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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PRIZE ESSAY, JANUARY 1, 1900.

TORPEDO CRAFT: TYPES AND EMPLOYMENT.

Motto: Experientia Docet.

By LIEUTENANT R. H. JACKSON, U. S. Navy.

The navy list on July 3, 1899, showed that we had, completed, twenty torpedo craft, and building, thirty-three more; in all practically fifty of these vessels.

It is now time to ask ourselves what success we have attained with these vessels, and what should be accepted as the standard type for performing the functions required for such vessels.

Three years ago a paper on this subject, written by Lieutenant R. C. Smith, U. S. Navy, was published in the Institute; he outlined the practices of the builders abroad at that time, and deduced from them, from the conditions to be fulfilled in our service, and finally from what experience had taught us with the two or three boats already built, that two types of boats were essential, advocating the building of only these standard types; he also pointed out some of the objections that would result from great variety in size and type.

Let us then examine our list of torpedo craft and see if t can be classified into two types. It will be seen at once t any attempt to arrange them according to length, displacem speed or armament is practically impossible. It is only in destroyer class, where a batch of sixteen were laid down at time that there seems to be anything like a standard. In class we can say that there are sixteen boats with displacem of from 400-420 tons, with horse-power from 7000-8300, an speed of 30 knots over a 30-mile course. Having set this t to one side as a destroyer class, there remains on the list torpe boats from 46-175 tons, intermingled with destroyers from tons to the standard destroyer of 420 tons; speed from 2 knots; and an armament of torpedoes and battery with but l more regard to law and order.

It is natural that these conditions have arisen, and far f regretting that such is the case, it may prove to have bee considerable benefit if properly considered.

Some of the reasons for our heterogeneous collection of pedo-boats may be found dependent upon the following co tions:

(a) It was the desire and policy of Congress to scatter work throughout the country in order to foster the shipbuild policy, and to develop the specialty of building small craft. T allowed many small firms that had but little experience in bu ing vessels of this type to bid and submit plans, as it requi but a small plant to turn out these vessels.

(b) Besides the variations resulting from the acceptance plans of the different contractors, other variations consta arose from practical difficulties met with by the contractors carrying out the specifications. Some of these, no doubt, w due to lack of skill on the part of the contractors, and others faults in the Department's designs; others possibly to a de on the part of the contractor to use a cheaper and possi equally good design to replace the more costly one laid down the Department.

(c) Possibly a desire to build experimental types can acco for some of the variations.

At any rate we have them; and having them, a close study the performance of the different types, and their efficiency in t special rôle to which they should be assigned, ought to give much valuable information, and lead to the selection of two, or at most three, types of boats that can then be standardized as far as possible.

In order to decide upon these types, information may be obtained from three sources.

First. The practice abroad of the leading powers. Until recently this has been almost the only source from which conclusions could be drawn; so, too, there ought to be a perfect familiarity with the results that are attained abroad with the different types in order to more closely judge the efficiency of our own types.

Secondly. The examination of the performance of our boats during the Spanish war, in which they performed almost every function except the one which properly belonged to them—that of attacking an enemy's fleet. Many important lessons in construction and engineering can be drawn from this source; but nothing tactical.

Thirdly. Consider the strategical points involved as a result of our isolated position, and the requirements for torpedo-boats that are demanded thereby. From this, certain qualities will be found as absolutely essential for one class of boats, and certain others as the essential features of another. Knowing, then, what is to be required of the boat, an examination of the performance of our own boats and of those abroad should enable us to select the type of boat as a standard, possessing such qualities to the highest degree, and all boats should then be required to conform to this standard even to the most minute details.

The advantage of possessing uniform qualities is even greater in its application to a flotilla of torpedo-boats than when applied to battleships. Equal speed, steaming radius, interchangeability of parts, all add materially to efficiency and economy of the boats.

Classification.—Before entering into an examination of foreign practice, it would be well to fix our ideas by the selection of certain standards of comparison. The following classification is based on the displacement as giving the best indication of the seagoing qualities of the boat.

(a) Class O. Destroyers. Boats of high speed over 200 tons displacement; carrying guns and torpedoes.

(b) Class P. Sea-going torpedo-boats (picked). All boats over 150 tons: they are capable of maintaining themselves at sea as long as there is a demand for their services; though on account of the relatively small number of officers and men, and the cramped quarters, they should be allowed to leave the squadron and return to port when opportunity offered.

(c) Class Q. Sea-going torpedo-boats (questionable). All boats between 100 and 150 tons; these boats are sea-going, but not sea-keeping; two or three days continuously at sea being about all they can stand.

(d) Class R. Torpedo-boats (stationary). All boats under 100 tons. They are properly not sea-going, as there is certain risk incurred in sending one to sea alone, especially for a sufficient distance to prevent her again reaching port before foul weather sets in.

The same letters are used in this classification, by displacement, as are used in the English Naval Pocket Manual (where the classification is by length), by far the most complete and accurate list of torpedo craft now published.

The principal changes from the tables given in the manual are: (1) it reduces very much Class P (sea-going), also known as sea-going torpedo-boats, throwing most of them into Class Q (questionable), also known as first-class boats; (2) it very much increases Class R (station boats). This class embraces all, or practically all, of the boats known as second-class, and some of the so-called first-class boats.

The following table shows the classification more clearly:

Class.	Displacement.	Name.	Loose Classification.
O....	209 and over.	Destroyer.	Destroyer.
P....	150–200	Sea-going, picked.	Sea-going.
Q....	100–150	Sea-going, questionable.	1st class and sea-going.
R....	Under 100	Station.	2nd class, station, vedette.

THE PRACTICE ABROAD IN TORPEDO-BOAT CONSTRUCTION.

In 1878 and 1879, England, Germany, France, and the United States built one or more fast launches of 60-100 feet in length and as high as 22 knots speed to be fitted with Whitehead torpedoes. During the next five years two or three 100-foot boats were turned out by Thornycroft and Yarrow, principally to fill the orders of the leading foreign governments.

Germany.—In 1883 Germany decided upon a type of boat, which was about 125 feet long, 85 tons displacement, 1000 I. H. P.

and 19-22 knots, armed with two H. R. C. and two tubes. In the next seven years she added 63 of these to her flotilla.

In 1892 she built sixteen boats, 144 feet long and 110-125 tons displacement, speed 25 knots; and in 1898 with 152 feet length, the displacement was increased to 140 tons, apparently to obtain greater endurance, seaworthiness and habitability. Her policy until 1898 had given her but two types of boats, sixty-three of the 125-foot length (19-22 knots), boats distinctly for station work; and sixteen about 125 tons (25 knots), boats for operating with squadron.

In 1898 the size increased to 140 tons, and there are now building eight of 155 tons displacement.

Conjointly with the building of these boats, Schichau has built eleven larger boats, known as division boats. They have been added in the proportion of one to each seven boats, and are supposed to be the flag-boats of the divisions as well as to render aid to a certain extent to the other boats. They are between 250 and 300 tons, speed increasing from 21-28 knots, according to the date of building. Only the last of these boats, No. 11, has twin screws; while of the eighty-five torpedo-boats already mentioned, none have twin screws. The armament of these boats, originally two 37-mm. guns, has now been replaced by 3-pdr. R. F. G. and .31 cal. machine guns; with two or three torpedo-tubes, according to their displacement.

There are also twenty boats built by different firms between 1884 and 1887 that are less than 100 tons and have twin screws.

England.—England was conservative as usual. Her pioneer private firms were selling boats abroad before she began to build; but with her liberal appropriations, she has carried the boats forward more completely than any other nation. The history of her policy will consequently be the most instructive.

Starting with 86-foot boats in 1878, she seemed content with watching the results of the efforts of her builders to fill the orders for one or two boats for foreign governments, till in 1885 she ordered the Swift, 150 feet long, as the first attempt to get a sea-going boat. In 1885-86 she decided upon a type close to the type selected by Germany two years before, *i. e.*, 125 feet long with somewhat less displacement (60-75 tons), and ordered fifty-seven to be built at once.

The next year, on account of gradually increasing speed obtained by several firms, she built a boat 135 feet long, with speed of 23 knots. In 1887, Yarrow sold a 140-foot boat, speed 25 knots, to Spain; and Thornycroft a slightly smaller boat, speed 26 knots, to Italy.

In 1893-95, England built ten boats 140 feet long and 100-130 tons displacement, which she tested the next year in her squadron manœuvres; as well as her seventy small station boats about 125 feet long.

These ten were the last torpedo-boats built by her, the destroyer having replaced that sea-going boat for service with the fleet, leaving her ten sea-going station boats of the first class and seventy-five vedettes for harbor defense.

Destroyers.—On account of the unsatisfactory speed of her torpedo gunboats, England, whose rôle is to protect the fleet, ordered (1893-95) thirty boats called destroyers, the rôle being to supplant the gunboat in protecting the fleet from torpedo attack; and further, having sighted the torpedo-boat, to overhaul and destroy it. Thirty were built immediately, 190-200 feet long, 220-280 tons displacement, and 27-29 knots speed. Seven slightly larger boats were built the same year, length 210 feet, displacement running up to 300 tons, and speed to 30 knots.

In 1895, during the squadron manœuvres, these destroyers were tested with such satisfactory results that England has made no addition to her torpedo-boats since that time; but has increased her destroyer flotilla from 50 in 1895 to 118 in 1900. The only change in type being an increased size and power. One of her latest laid down is as follows: Displacement, 420 tons; I. H. P., 9000; speed, 33 knots; armament, one 12-pdr., five 6-pdrs., two tubes and four torpedoes.

Among the tests in 1895 was one to prove the power of the destroyer to catch the torpedo-boat. Without any preliminary notice, twelve of the best torpedo-boats, with a speed of about 20 knots in a smooth sea, were sent at full speed toward port 40 miles distant. After giving them twelve minutes start, the destroyers were sent after them. The chase was over in eleven and one-half miles, and lasted about thirty minutes. Four of the boats escaped, the highest speed logged by them being about 20 knots. Some of the boats broke down, as did two of the destroyers.

Good results with the destroyers were also obtained in firing at a target when running by at a 30-knot speed, and in discharging the Whiteheads when running from 20 to 30 knots. Experiments were also made as to the ability of the destroyers to block all the boats in port, and protect a fleet passing along a hostile coast. The results of most of the work in 1895 were kept confidential, but an extract from a letter written by a capable naval officer who took part in the operations says: "The impression left on my mind by the manœuvres was that all the present types of boats are obsolete, and that probably no more [like them] will be built. But I believe that boats of the size of the destroyers will take their places in every navy." This certainly has been the policy of Great Britain. In 1896, in addition to the fifty already turned out of 27 knots, she laid down thirty more similar to the seven already noted, of 300 tons displacement.

FRANCE.—TORPEDO-BOAT POLICY.

France in 1878 began with an 86-foot torpedo-boat of 30 tons and 19 knots, about like the Stiletto in our service, but slightly smaller. In five years she acquired about fifty of these, and has built no more. When new they made from 16-19 knots. Her vedette boats—13, including 7 aluminum boats of 60 feet and 15 tons displacement—she has shown no desire to increase. The first type (10) she armed with 37 R. C., and on the remainder she has placed two 1-pdr. R. F. guns, and two torpedo tubes. This is now her armament for all boats except her sea-going boats.

While she was building her 86-foot boats, third class, she also (in 1878-83) turned out eighteen 110-foot boats, about the size of the Gwin.

In 1885 she made a large program for accession to her torpedo-boat flotilla, and in the next four years added 60 to this Gwin type though 15 feet longer and of somewhat less beam. All of her boats to this point were second-class boats having less than 60 tons displacement with over 100 feet length. At the same time a program was brought forward for building a certain number of boats of tonnage between 60 and 100, and length exceeding 100 feet. These were to be designated as first-class torpedo-boats.

The type selected had the following characteristics: Length, 134 feet; beam, 11 feet; depth, 7 feet; tonnage, 67, and I. H. P. 700 to give 20 knots with single screw.

From the experience obtained from these boats a new type o first-class boat was adopted two years later, with the followin characteristics: 118 feet long, 13 feet beam, 8½ feet draft, 7 tons, 1300 I. H. P., 23 knots with two screws. The modification in general terms being as follows: adding a second engine o same size, thereby doubling the I. H. P. and giving a speed of 2 knots instead of 20. The boats now being 16 feet shorter, tw feet more beam, 1½ feet more draft, on about 12 tons more displacement. This seems to have been satisfactory to the authorities for station work, as they were gradually added until in 189 there were sixty-four of them practically identical.

In the armament of these boats she has been consistent.

The construction of sea-going boats began in 1889. In 189 the Forban, built by Norman, led the world with 31.5 knots During this time she built thirty-four 100 to 150-ton boats, lengt 140-160 feet, with every apparent variation in speed, armament and coal endurance, without regard to dates of building. Th armament varies from two 1-pdrs. to three 3-pdrs., this last battery being put on the smallest of the class; and the tubes varying from two to four.

Summary.—(*a*) Briefly outlining the results of France's torpedo policy it is seen that commencing in 1878 she built second- and third-class station boats, possessing, in 1885, fifty small Stilettos and eighteen Gwins. She then abandoned her Stilett type and in the next four years added sixty to her Gwin type, though 15 feet longer and somewhat narrower. At the same time she made her first attempt with a first-class boat, *i. e.*, 60-100-ton boats, and laid down ten resembling the McKenzie, but 34 feet longer and of a little less beam. These were evidently failures; for shortening the length 16 feet, increasing the beam 2 feet, and using twin screws, she has reached her present type which will be referred to as the French station type.

She seems to have been unable to decide upon a sea-going type.

Her present flotilla comprises fifty Stilettos, seventy-five Gwins and ten McKenzies, none of which types she would duplicate. Also sixty-three first-class, and thirty-five sea-going boats of 120-130 tons of questionable sea-keeping power. It may be safely assumed that none of these are capable of remaining and operating with the fleet, but must always rest on a station as a base.

(*b*) Germany seems to have obtained a good type in her sixteen boats of 125 tons design, their principal objection (a bad one however) is that they have single screws. Any boat required to operate at sea more or less independently must have two engines to insure her safety. A torpedo-boat comes into port under one engine far oftener than is supposed.

(*c*) England's last sea-going torpedo-boats (10) built in 1896, about the same size as Germany's (110-130 tons) boats but with twin screws, were satisfactory, but had not the sea-keeping power demanded by her policy, nor could they fulfill the tactical demand for the destruction of the enemy's boats, called for in her offensive rôle. Hence her destroyer.

France, ever trusting in her ingenuity and theoretical schemes, which lean toward the performance of miracles, has now directed her attention to submarine marvels, after having created an enormous flotilla of small boats practically none of which are sea-keeping.

Conclusion.—From all of this we find that a good twin-screw sea-going, but not sea-keeping, boat can be obtained between 110 and 130 tons. While the destroyer must be over 250 tons, with a tendency to increase its size. England's largest destroyer, the Express, is 420 tons and 9250 I. H. P.

Having looked over the navy list of the leading powers of Europe it is seen that they have quite as heterogeneous a collection of boats as are shown on our own list with the difference that they have large groups of each. This does not mean that they have found a need for each group, but rather that they represent the costly steps leading to present practice. The present practice shows but little variety in types.

These then are the types that foreign practice would lead us to adopt. After considering the information from the other two sources we will compare them.

Secondly.—THE PERFORMANCE OF OUR OWN BOATS DURING THE SPANISH WAR.

As the boats made no torpedo attack, the principal points upon which information can be gathered are, habitability, seaworthiness, sea-keeping power and durability. An investigation of these points will divide the boats into station, and sea-keeping boats; and in addition the destroyer class; a brief record of the performance of the different boats that took part in the Spanish war will be given, starting with the smallest of the class.

The Gwin and Talbot, sister boats of 46 tons displacement, o
engine, one boiler, and speed 20 knots, arrived at Key West t
middle of July, having come down through the canals as far
Ocracoke inlet. The McKee, a boat of the same class, exce
that she is equipped with two boilers, came at the same tim
About the first of August, in response to the restlessness of the
commanding officers, they were sent out on the blockade off t
north coast of Cuba from Cardenas to Cay Frances. Their sp
cial function was to pass in among the shallow inlets behind t
Keys and capture and destroy all cargo-boats, sloops, schooner
and fishermen suspected of rendering assistance in dischargin
the cargo of blockade runners. The steamers entering the
ports could not get up to the towns for lack of water, yet cou
remain concealed behind some of the Keys till discharged. T
Foote and Cushing, 140 and 105 tons respectively, twin scre
and two boilers, were also on this expedition. It was expecte
that large ships of the blockading squadron would be found
the neighborhood; from these supplies were to be drawn, an
upon them they could depend for defense from the Spanish gu
boats, of which there were several in the principal ports. The
parent ships turned out to consist of one or two auxiliary co
verted yachts that were but poorly equipped with coal and wate
and even they were soon separated from the boats. The Talb
having smashed in her bow in a night collision while carryin
despatches, the other boats cruised in pairs among the Key
chasing and capturing all the craft that dared appear, even
sight of gunboats that usually contented themselves with pour
ing dense volumes of smoke from their funnels upon sighting th
torpedo-boats. The gunboats ordinarily lay alongside of th
docks, content to be let alone.

On this cruise one of the torpedo-boats, having but a singl
boiler, was troubled with a leaky tube. So, lying under Piedra
Key, she cut out and replaced the tube and brought off in boat
enough water from a cistern on that island to again fill the boiler.
Just how long these little craft could have remained on this sort of duty it is difficult to say, as any passing vessel could supply them with coal and water and a little hard bread and canned meat. When they returned from the blockade on the 10th of August, the preliminaries of peace having been arranged, they could certainly have remained a week longer without any additional supplies.

These boats then showed their ability not only to operate from a fixed base such as Key West, but also to utilize the larger vessels on the blockade as a base, and efficiently carried out the rôle of shallow draft gunboats in passing among the Keys and suppressing all commerce across the interior waterways, though they were never designed for this work.

Cushing, Ericsson, and Morris. These somewhat larger station boats did not have very much duty during the war. The Cushing and Ericsson saw such very hard despatch duty just before the war as to necessitate very extensive repairs. The Cushing accompanied the other boats on the blockade on the first of August, and stayed out until the boats were recalled from the blockade. The Ericsson, though constantly breaking down, and returning to port, scored a point in being the only torpedo-boat on the scene of action on the day of the Santiago fight. This was due more to the ingenuity, patience, and perseverance of her commanding officer than to any good quality of the boat. The Morris did not arrive till near the end of the war and did not leave Key West.

The Foote and the Winslow went out on the blockade of Matanzas, Havana, and Cardenas at the outbreak of the war. The Winslow's career was about finished on the tenth of May when she was disabled by the gunboats at Cardenas. She had seen several days of service on the blockade up to this time.

The Foote remained on the blockade for about seven weeks, coming in twice for mail and despatches and fresh food for herself and the other ships occupying that station. She was then withdrawn, being relieved by the Leyden. After about two weeks' overhauling at Key West, principally renewing the boiler fronts, she was again ready for work; but was not sent out again till August when she returned to the blockade of Cardenas and ports to the eastward as already stated. She remained there till recalled at the end of the war.

Porter and Dupont. These two boats were at Key West at the outbreak of the war. They went on the blockade as did all the others. But the Porter was then assigned as a despatch boat to the New York, and the Dupont soon returned to Key West, where she was held in reserve by the station ship for despatches. The Dupont made two long trips, accompanying a squadron to Cienfuegos, and going out to meet the New York on another occasion. She was also at Guantanamo at the end of the war. Her record for steaming during the war was about 9000 miles.

The record for stanchness, sea-keeping power, and general excellence belongs to the Porter, which held the record of 12,900 miles of war service, on despatch and blockade duty, without other repairs than those made by the force on board. About the 20th of July she went north for general repairs, and a complete overhauling, her boilers having reached their limit of endurance.

Thirdly.—STRATEGICAL AND TACTICAL DEMANDS.

The West Indies has ever furnished a battle-field for naval wars; and so will it be in our next war. The importance of being able to control its waters will be doubly accentuated by the need of controlling the Nicaragua canal.

Destroyers.—The fleet of battleships must be maintained in these waters, and their safety from torpedo attack by the enemy must be insured by the destroyers. So that a flotilla of these in the proportion of two for each battleship would be a fair allowance. They must possess the speed sufficient to catch a 25-knot torpedo-boat, and the sea-endurance to remain with the fleet without being a constant source of anxiety to the commander-in-chief. A small, but powerful battery, and comfortable quarters for the crew are the essentials. Two torpedoes furnish a sufficient armament to give all of the moral effect of the torpedo-boat. Moreover two torpedoes carefully fired would be as good as half a dozen.

Sea-Keeping Torpedo-Boat.—In addition to this flotilla of destroyers associated with the fleet of battleships, the commander-in-chief needs an offensive weapon that can be used against the hostile squadron which may be operating in some portion of the West Indies or which is making a feint at some point along the coast. This may be only a detached squadron; yet something must be done to meet it.

Twenty sea-keeping torpedo-boats such as the Porter can be made to cover long distances at good speed, without being seen; make an attack and disappear, leaving the enemy in such a demoralized state that they will fall back on their base, or at least withdraw from that vicinity. Their employment as mounted infantry and light artillery combined would in the hands of an energetic commander-in-chief be most demoralizing.

Station Boats.—Turning next to boats of limited endurance which should be classified as station boats, they can be tactically classified under two heads. (*a*) Sea-going, capable of continuously operating for two or three days at a moderate distance from the base. To this class belong the Cushing, Ericsson, Morris, and even the Winslow. They are capable of selecting any point on the coast as a base, and can be rapidly mobilized at such point if scattered along our entire coast-line of a thousand miles.

(*b*) Station boats whose operations are practically limited to a single night's attack, designed as a part of the coast defense system, operating through the inland waterways from Lake Erie and Buzzards Bay to Fernandina, Fla. Boats of this class are the Talbot and the McKenzie, the Cushing being almost too large for such work. The number of these boats required should be sufficient for the defense of Massachusetts Bay, Narragansett Bay, New York Bay, Delaware Bay, Chesapeake Bay, Charleston, Galveston, San Francisco Bay, and Puget Sound. A pair of these boats at each of these points would give a certain feeling of protection to the people, and liberate more valuable and powerful vessels for offensive operations. With the ten monitors now complete or building distributed at these same points, the Secretary of the Navy would be able to give a satisfactory answer to the clamor for local protection. In the case of imminent danger at any point on the coast this force could be concentrated to resist such attack, though this movement could not be rapidly effected. We already have the ten monitors which are especially fitted for this rôle; and the cost of sixteen more Talbots would be about one-fourth the price of one battleship.

Having now examined the three sources of information we can apply our knowledge to the selection of types having due regard to the rôle which each type will be called upon to play in actual war.

In order to have present practice abroad in a readily available form the following table has been arranged which is fairly accurate, the conflicting statements of the different sources of information upon this subject making it very difficult to obtain correct data.

Nation.	Type.	Built.	Building.	Displacement.	Length.	I. H. P.	Speed.	Armament.
England ..	Destr.	108	10	300	210	6000	30	1 12-pdr., 5 6-pdr. 2 T.
	Boats	98	..	...	...	..	..	
France. ..	Destr.	4	8	300	185	4800	26	1 9-pdr., 6 3-pdr. 2 T.
	Boats	211	8	152	144	4200	30	2 3-pdr. 2 T.
Russia....	Destr.	1	28	240–350	196	3800	27	3 1-pdr.
	Boats	174	17	120	...	..	..	
Germany..	Destr.	1	5	350	210	5800	28	5 3-pdr. 3 T.
	Boats	113	9	155	157	2500	25	1 R. F., 1 mch. 2 T.
Italy	Destr.	..	8	320–350	196–208	6000	30	1 12-pdr., 3–5 6-pdr. 2 T.
	Boats	142	2	150	156	2700	25	2 1-pdr. 2 T.
Japan	Destr.	..	8	275–300	220	6000	30	1 12-pdr., 5 6-pdr. 2 T.
	Boats	44	12	130	148	2000	26	2 3-pd.
U. S..	Destr.	..	16	420	245	8000	29	2 12-pdr., 5 6-pdr. 2 T.
	Boats	20	11	165	175	3000	26	3 3-pdr. 3 T.

REQUIREMENTS OF DESTROYERS.

Speed.—The boat must have sufficient speed to overhaul a torpedo-boat and disable her. It is well to remember that at night the discovery will be made at close range, and but a slight superiority in speed will be sufficient to enable the destroyer to close sufficiently to prevent the boat from eluding her, and enable the gun captain to hit his indistinct and difficult target. The flare from the stack of the fleeing boat, when she is pressed to her limit of speed will materially assist the destroyer unless the rain, snow, or fog intervenes. In daylight the discovery of the torpedo-boat is not likely to be made at more than five or six miles, so that a difference in speed of three knots would give the destroyer the necessary superiority. A speed of 28 knots that can be maintained for six hours is sufficient for all purposes, and gives a surer indication of the value of the boat than a delusive 32 knots with bottled up steam over the measured mile. To attain this result the machinery must not be shaved too light. The results of the performance of some of these boats abroad during the last year indicate that the factor of safety is too small, and that the number of revolutions allowed is beyond safe practice, making the strain on the moving parts tremendous; any slight flaw in forging or tempering, and the engine room is a wreck—if there is no worse result. Let us not be carried away by the desire for the fastest boat in the world. Moderate revolutions and steam pressure and stanch machinery, and we can challenge the speeds shown in the table and feel that we have the better boat.

Armament.—Five 6-pdrs., one 12-pdr., two tubes and two torpedoes.

The argument in favor of this battery is found under the head of Criticism on Ordnance.

From the table it is seen that our armament is still the equal of any nation, and superior to most, except in the number of torpedoes carried on board. It is well to bear in mind that some of the boats do not in practice carry *both* torpedoes and guns; one or the other is left ashore.

A liberal allowance of coal and water must be carried, remembering that at night the boats must be actually cruising. During the day by running slow under one engine and carefully tending the two large distilling plants that are needed she can replenish her water supply. In case of necessity coal and water can be supplied from the big ships such as the New York, and the distiller ship; but it is best to be self-supporting as weather and unusual circumstances may make assistance impossible.

Displacement.—Before deciding upon the size it is well to bear in mind the two distinct rôles in which the destroyer appears.

First. She is a terror to all torpedo-boats; her powerful battery, relatively high speed in all weathers, and shallow draft leave them but little hope for escape, unless a lucky shot at long range disable her. In this rôle she acts as the night policeman for the fleet, easing the nerves of the battleship.

Secondly, and this is a point that is likely to be forgotten, she is a terror to the enemy's fleet; for not only does she carry the same torpedoes, and will appear from more distant points, but she still retains that essential element to successful attack by surprise, a relatively small size and consequent invisibility. It is the failure to recognize this essential quality that has led to the advancement of a type of boat of 600-800 tons displacement, which is based on the sound doctrine "the bigger the better" when coal endurance, stanchness, comfort, and speed are the qualities desired. The "long low rakish craft," this invisible terror of the seas, must be retained, as in the piratical days of old, to destroy a few and strike consternation to the hearts of all.

We have reached the happy result, but the outside limit, in our 420-ton destroyer. It is well to remember that foreign practice tried this 800-ton boat several years ago in their "avisos" and scouts, which were afterwards abandoned, and then developed the torpedo-boat to its present size. By examination of the table it will be seen that even now we lead all other powers in the displacement adopted.

Torpedo-Boats, Class P.

Requirements.—Only sufficient speed is needed in vessels of this class to make it possible to overhaul and attack a distant fleet cruising at a moderate speed. Twenty knots is thought to be a good sustained speed for an all-night run in moderate weather. This would give a 25-knot speed for the dash to escape after the attack. A boat that can be relied upon to do this should be able to maintain a speed of 25 knots for six hours in smooth water.

A flotilla of these boats would temporarily accompany the squadron till the commander-in-chief decided upon the point of attack, or received information of the enemy which would permit a blow from this mobile arm of his fleet. After the attack the flotilla would probably return to the nearest base. They are expected to join the fleet whenever needed, and to remain till the attack has been pressed home. But the admiral would leave them resting on a convenient base till the time seemed ripe for the blow.

The armament thought best is three S. A. 6-pdrs., two tubes, and two torpedoes. The reason for this selection is found under Criticism on Ordnance.

Displacement.—The displacement must be kept as small as is consistent with sea-keeping power. These boats must be able to keep with the squadron through all weather; and have a crew, coal, and water sufficient to be counted on for a week, and still be able to return to port. The Porter seems to have been able to fulfill these conditions under the test of war; yet no smaller boat seemed to be able to come up to this requirement, so that 165 tons seems to reach the sea-keeping power combined with a size that permits of a successful surprise in a night attack. Great Britain alone has recognized that boats of a smaller type than this fail to attain this sea-keeping requirement. She reported adversely upon her largest torpedo-boats in 1896, and since then has built nothing smaller than the destroyer. The table shows that France and Germany are trying 150-ton boats, their first venture in boats of such great displacement, France, alone, with her desire for the marvelous, stipulating a speed of 30 knots. Twenty-five knots maintained speed answers all requirements. The table shows that for our 165-ton boat the armament is superior to that of any boat abroad; but three 6-pdrs. would make her a Tartar for destroyers and small gunboats.

STATION BOATS, CLASS Q.

There does not seem to be any need for this class in the scheme for coast defense, and they are not sufficiently powerful for offense. So that though the ten that we have thus far acquired are quite useful for drills and exercises in our home ports, and will make good station boats for the West Indies, there seems to be no reason for duplicating any of the six types represented by the ten boats in this class.

As for the Manley no one seems to know for what she was designed or why she was bought. Possibly it was to give us wrinkles in design and construction. This was a reason that I heard advanced for the purchase of the Somers. This boat, 150 tons, has but a single screw, and when the attempt was made to bring her over she leaked so badly as to require her return to port. After the war she was brought over in a freight steamer. She has the lines typical of all the Elbing boats. She carries an underwater bow tube, which may have been the cause of her trouble. At any rate Germany has lost three boats by foundering at sea, and it is thought that they were on these lines, though smaller. In the latest sea-going German boats there is no submerged bow tube and no forward conning tower.

STATION BOAT, CLASS R.

As already stated, twenty boats of the Talbot type, with a 1-pdr. forward and a machine gun aft would cover the conditions for the defense of the waterways and harbors.

Having decided upon our general type let us examine the details of construction, equipment, etc., on board our boats to see if they have stood the best test of their value, viz., satisfactory results on boats in commission. This examination will be taken up according to the classification by departments on board ship. The writer is encouraged to make this minute and detailed examination by the generous desire shown by the bureaus concerned to make the changes suggested and remedy the faults where a remedy could be pointed out.

DETAILED CRITICISM AND COMPARISON OF CERTAIN POINTS IN CONSTRUCTION.

In no way is the difference between an experienced builder and the novice so evident as in the details of hull construction, and its fittings, and in the use of some little device learned by experience, which often adds materially to the efficiency and comfort of the boat.

Consequently, the writer does not believe that any detail is too trifling to criticise, especially if a remedy is easily found. A striking example will first be given to illustrate the point, before going into an enumeration of details.

A large ventilator was placed over a cabin in order to give fresh air to the sleeper. The result was a wet bunk all the time; at sea it was salt water; in port, rain or sweat from the plate on the inside. In practice the bottom of this ventilator was kept tightly closed by a plate, and a canvas hood placed on the outside when going to sea.

Ventilators.—Experience would indicate that all attempts to ventilate compartments by means of small ventilators are failures. The discomforts and damage inflicted by salt water and rain more than offset the possible advantage of these few small air pipes. The only exception to this is for the compartment containing the closets, where there is usually little to spoil by salt water.

With this exception, there should be no opening in the deck from one end of the boat to the other except hatches and coal-bunker scuttles. The hatches should be arranged with some device allowing them to remain open and yet keep out rain and spray, even though occasional seas sweep on board.

On one of the boats of the Winslow type, canvas hoods were fitted over the hatches of the principal compartments (*i. e.*, the living spaces and the engine-rooms), which were lashed around the hatch coaming and carried up about two feet, and the opening left on the lee side. These were only put on in bad weather. An excellent device is found on some boats. The hatch-hood is a quadrant of a cylindrical section, one side fitting over the hatch, and the other open to the air, ordinarily looking forward. The upper half of the periphery opens or closes by a sliding shutter. Shutters, either sliding or swinging, can also be fitted to the side that looks forward.

The advantages of this arrangement are that: (1) In fair weather the sliding top can always remain open unless the sea would enter a hatch with 18-inch coaming; (2) in falling weather, by hauling over the sliding shutter at top, and shifting hood so that the side opening looks to leeward, no water will enter. In ordinarily good weather, with sliding shutter on top hauled back and side shutter open, entry and exit are in no wise impeded. With an ordinary cowl the hatch cannot be used for this purpose. This hood of course having a rectangular base, has only four positions, abeam, and fore and aft; but its efficiency seemed little reduced thereby; while its usefulness in all weather recommends it greatly. They should undoubtedly be fitted to each living compartment, and seem to be equally adaptable as hoods for blower-engines in firerooms. When fitted over blowers they should have light wire screens, say a 2-inch mesh, to prevent signal-flags and wash-clothes from going into the blower.

Each living space should have two openings, to facilitate exit and also to give proper ventilation. For the two principal spaces, the cabin and the crew's space, the conning tower can be utilized for one of these, and a hatch, as above described, for the other. If an old-fashioned windsail is then rigged in the hatch or tower, as best serves, a good supply of air will be insured in these two compartments in practically any weather, a condition that has often been denied our boats. A scant supply of air at 115 degrees, and that mixed with salt water, will lay low the toughest mariner, and result in a short time in a disabled crew and boat. Few of the boats during the war, whe subject to these conditions, could boast of a man who had no been seasick.

The air ports on the sides abreast the living quarters are ver convenient, and, when reasonable care is taken to renew th gaskets when softened by heat or oil, are satisfactory.

Referring again to the ordinary round top cowl or hood, a objection to it was noticed which may be new. When a ma is feeling his way along the deck at night in rough weather an has seized the rim of the cowl, instead of getting support from it, the cowl, revolving from his weight, has sent him stumbling against the rail with the roll of the boat; on one occasion th cowl came off and the man was with difficulty saved from going overboard.

Clear Decks.—While on this subject of ventilation and deck openings, too much stress cannot be laid upon the necessity fo clear decks. There should be no openings in the decks excep for the blowers, the passage of men below, the coal scuttles and a large hatch over each engine. All these, when closed should offer an easy gangway for travel fore and aft. Especially should this be true of the coal scuttles and engine-room hatches. A satisfactory scuttle, flush with the deck and reasonably tight when cared for, is a rectangular brass plate held down by dogs against a rubber gasket fitted in a score around scuttle. A passage along the decks of some of our boats on a dark night is at the imminent risk of going overboard, to say nothing of the condition of shins which is sure to exist as a result.

Deck Covering.—After a good deal of experimenting on the suitable covering for the deck the choice now seems to lie between linoleum and gratings. The most satisfactory result has been obtained by laying gratings along the line of traffic fore and aft, and holding them down by movable cleats, so that they can be taken up without much trouble, and yet will not wash overboad in a sea-way. In case of abandoning the boat these are useful as life-rafts, as they can be loosened in a moment.

The only advantage possessed by linoleum over gratings is a reduction in weight, and this is not great; its disadvantages are: (1) lack of durability, being easily punched full of holes and torn around the edges; (2) difficulty in securing it to the deck, as on any other than flat deck boats the first sea will catch under a loose edge and rip up a whole sheet. It then requires a dry, warm day to stick it down. Also, if water lodges under it, the deck will rust badly. Then, over the fireroom, the different coefficient of expansion of the linoleum and steel will always loosen those sheets.

Linoleum has been satisfactorily used as follows:

On the Talbot class by holding the strips over boiler-room down by one-quarter inch strips of steel along the edge secured through the deck by round-head stove bolts. This system could be applied throughout, using galvanized iron or brass strips on the edge of each sheet of linoleum, and holding it down with screws through the deck.

On the Winslow, which type, being turtle-back, have given the most trouble, a sort of combination of grating and linoleum has been adopted. Wooden strips, 3 inches wide and 3 inches apart, run fore and aft, held down by screws; under these wooden battens are linoleum strips. The arrangement prevents slipping, but as the foot finds no complete support either on the battens or between them, it would soon become disagreeable and tiresome when one moves about the deck. Rubber matting, which has been tried on some boats, is not only soon broken to pieces but is actually heavier than the grating.

Below Deck.—Below decks, the floors in the living spaces should be of hard wood. In the cabin compartment a covering of thin linoleum tacked down on some light wood, as soft pine, works well; when given a coat of shellac once or twice a month, this gives a durable floor, easily kept clean and dry in all weathers. In the crew's quarters a coat of shellac each week applied to the bare hard wood, gives the best result. All this wood should be soaked in paraffine or electro-proofed to prevent absorption of moisture from the bilge and swelling, so as to make constant misfits of the movable hatches. As electro-proofed wood is said to cause corrosion of steel, the edges of the floor that come in contact with hull should be oiled or painted to prevent such a result.

More permanent discomfort has existed on board the boats from a failure to give a thin canvas lining to all living spaces than from any other cause.

In the Cushing, which in her early days boasted four officers in her cabins, icicles hung from the "roof" in the morning, and rheumatism was common. To remedy this an inner lining of canvas was fitted, leaving an air space the depth of the frame between it and the deck. This probably reduced the sweating, and any moisture that was precipitated ran down the side behind the inner lining and then into the bilge. On some boats where this lining was fitted, the outboard side of the men's lockers being the skin of the ship, the streams trickled into their lockers with the result of wet clothes and more rheumatism.

On the vessels of the Winslow type the men had to sleep under rubber blankets until linings could be fitted. Very thin boards have been used at the side instead of canvas, but this raised the objection of splinters from a shell. The canvas is neat, light, and durable.

While on the subject of inner lining, it is well to say that this offers additional hiding-places for the pest often brought off in wash-clothes; but it has been found that the use of Persian insect powder every two or three weeks, closing up the compartment tight for an hour while the powder was being sprayed, was not only a prevention, but a cure for all crawling creatures.

Living Space Steam Heat.—Here again has experience done much toward securing a system and arrangement that have added greatly to the comfort on board the boats. The most remarkable arrangement was a case where the radiator in the cabin was placed at the highest point of the bulkhead. This would give in cold weather a temperature of 90 degrees at the overhead deck and 30 degrees on the floor. If there was any ventilation at all the occupant always enjoyed the temperature of the outside air, even though it was 20 degrees.

By the simple arrangement of carrying a 1½-inch pipe along the floor close to the lockers, the ventilation and heating are easily arranged. This position of the pipes also assists in keeping the lockers dry. It is well to always have at least one more steam-pipe parallel to the first, extending a part or all the length of the other, with a valve at each end; by this means additional heating surface can be thrown in for severe weather. On the Cushing, by this arrangement, from one to four pipes could be used as desired; after they were installed she was always comfortable.

A radiator is a source of discomfort. It is like a red-hot stove in a small dining-room. The one who sits next to the stove roasts, and those further away freeze. The crews, on account of the size of the compartment, are always at the table.

In connection with the steam-heater pipes there must always be an efficient steam trap intelligently tended. Ignorance on the part of the man on watch in the engine-room is often a cause of cold steam-pipes banked up with water.

Sinks, Basins and Closets.—The closets are, generally speaking, as satisfactory as under-water closets can be. Occasional trouble is experienced from ignorance in the use of the valves and carelessness in throwing waste and similar objects in the bowls. A good safe practice, however, has been to shut off the sea-valves when underway for many hours, if the weather be rough, and not depend on the interior valves for controlling the water. When the closet is used the valves can be opened temporarily, and again closed. The use of proper closet paper is a necessity if the closets are to be kept in order.

The pantry and other sinks should all be fitted with an automatic valve, such as rubber ball, etc., to keep the pipe closed from the sea, opening only by pressure of water from the basin; otherwise the water will boil up into the basin when at sea, and a precious pint of fresh water be converted into salt by the lifting of the stopper in the basin. In the Winslow type, when at sea, it was always necessary to put permanent plugs in the bottom and overflow pipes, and then bail out the water after using, making it much more inconvenient than a tin basin and pitcher would have been. Needless to say, the automatic valve should be easily accessible, to examine and take out the stray articles that are sure to find their way into the pipe and stop it up. Especially does this apply to valves for the closets.

Living Quarters. Position.—The arrangement generally adopted for officers, and if there is space, petty officers, forward, meets with best results. The place of the officers, especially if there is but one, is by the wheel, which can only be attained by placing his cabin near it. As the steering is all done from the forward tower, this reason alone is sufficient for the officers' quarters remaining forward. As to the comfort, it is in many cases an open question, as the heat from the steering engine and fire-room is often intense, the ventilation in a rough sea is almost nil, and the quarters are often drowned out. The advantages are, ordinarily, less cinders and dirt, and less vibration, though these conditions are not always true. It is important, if possible, to have the chief petty officers separated from the crew.

Tables.—The solid table, that is, one with the sides closed in so that it is stowed completely with crockery, tableware, war-heads, etc., is most satisfactory, being fitted with a leaf on one or both sides to permit a free gangway. Swinging and folding tables have been tried on several boats and have always proved unsatisfactory. They are troublesome to set up, unsatisfactory to eat on, and bulky to stow away; moreover, a table is in constant use all day long, and is a great convenience as a temporary receptacle for charts, books, bundles, writing-desk, and a thousand other purposes at all times. I recently noticed that the crew of a certain torpedo-boat took all their meals squatting round on deck; upon going below I found that the boat had been fitted with a swinging table that was stowed away in a corner and never used.

Chairs and Stools.—The best and most efficient are the simplest camp-stools of light design without backs and seats covered with canvas. These can be scrubbed and kept white, or given a coat of shellac or paint as is most practicable. About the best chair for comfort, compactness, and durability is the cheap steamer chair, made of two crossed pieces on a side, holding in varying positions a strip of canvas.

Ice Chests.—Many have been the makeshifts for this exceedingly essential fitting, which seems to be an afterthought. Starting with the Cushing, which utilized a hard-tack can, and continuing to the Winslow, which had a wooden box perched on the rail, exposed to the hottest rays of the sun and the all-penetrating salt spray, the best result has been obtained in the Talbot class, where a compact, light and serviceable ice-chest is built to the shape of the boat alongside the pantry. The additional supply of fresh food that can be carried with a properly equipped ice-chest adds materially to comfort, and the reduction in the mess bill is also considerable.

Bunks.—The system of bunks for the crew, two tiers, sleeping-car fashion, with pipe frame and laced canvas bottom, are excellent, being light, clean, and dry.

The upper berth system of the Pullman car seems on the whole to combine the greatest number of good features for the officers' quarters. This is a transom that folds against the ship's side when closed, and when made up swings out about 30 degrees, being held out by straps below. The bunk bottom, a canvas sheet, is fastened along the upper side of this transom, and is held out taut, and the mattress laid on this. It is comfortable and dry, because, except when in use at night, it can be closed up tight. Whereas a bunk that stands open may catch the unexpected sea or rain squall; and a wet bunk—there is nothing worse!

Officers' Quarters.—There has been a great variety in the arrangement of bulkheads, pantries, closets, etc., in the space allowed for officers' quarters, the idea most prominent apparently being to give each officer a room to himself. The result is a series of little cuddy holes, no one of which is habitable; whereas the same space with only one or two divisions would give quarters easily ventilated, reasonably cool and dry.

Taking the worst results first, there is on the Winslow ample space provided for living quarters; but analyzing it in detail there is not a comfortable spot in her. The captain's state-room, a separate compartment furthest forward, has a fixed bunk placed under two or three small ventilators, that will usually either sweat or leak on his bunk according to circumstances. The next compartment, the mess-room, has two transom bunks which are so low that the spray that comes in from the hatch overhead means no ventilation or a wet bunk, if the sea is at all rough. The closet is next, in a small compartment by itself. Abaft this on the port side a fixed bunk, with standing room alongside it; there is not room to sit down and undress, this being done by sitting on the bunk. On the opposite side in another compartment, two wash basins, fixed, for one officer; abaft this in another compartment, the pantry. In passing it may be remarked that the food was always hot, as the pantry was very small and separated from the fire-room by a thin bulkhead it served as a satisfactory oven to every one except the occupant, the steward. A space amidship between the pantry and washroom on one side, and the state-room on the other was useful only in admitting the ladder which occupied nearly as much space as the state-room alongside of it.

A great improvement could be made in this arrangement with but little expense. Considering the entire space abaft the mess-room, all partitions should be removed, and the arrangement of the floor space be as follows: on the starboard side aft, the closet and one wash-basin should be placed, the latter some small compact type, instead of the enormous aluminum one now in use. This compartment could be cut off by curtains or low partitions from the remainder of the space. If partitions are used they should only be about seven feet high, the angle irons running up to the deck overhead to prevent vibration. The remainder of the space would make a comfortable room. Below the hatch a vertical ladder would be secured to allow passage when necessary, but the main gangway would be through the conning tower. The hatch in the conning tower should be larger and more convenient ladders fitted.

The simplest and most satisfactory arrangement of officers' quarters would seem to be two compartments, one for each officer. The junior officer's room would contain two Pullman upper berths, placed well up on the side with a transom seat below each. This would also be the mess-room. The pantry would be placed as convenient, near or in this compartment. The senior officer's room would be the next compartment preferably abaft this, with the bath-room containing the closet and basin, and usually a fixed bath-tub, set off in a corner by a low partition and curtain.

The old idea of giving the captain complete seclusion from his officers, when carried out in a torpedo-boat is absurd; and he often has roasted or steamed in his effort to get rest in his own cabin; or else occupied his junior's bunk until time to go on deck and relieve him for a six-hour watch.

Of the two compartments contemplated, the captain should have the more comfortable one, and it might vary in the different boats. But in one should be the mess-table and in the other the baths, basin, etc., cut off by a low partition; the pantry being worked into the one or the other as the plan permitted. If these two compartments are separated by a low bulkhead amidships which could go all the way to the overhead deck toward the sides, ventilation through the hatch in the after one and the conning tower in the forward one would ordinarily be good.

In general each conning tower should admit to two compartments; that is it should be supported on the water-tight bulkhead with ladders down each side of the bulkhead. In case the compartment on the side forward of this bulkhead is a living compartment, *e. g.*, the mess-room, there should be a hatch with a reversible square ventilator hood, water-tight, fitted over it. This could face to leeward at sea except in exceedingly rough weather when it would have to be closed.

If a deflector running down 18 inches or 2 feet were fitted on the inside of a hatch nearest the bunk, desk, etc., it would often be a great protection and comfort. In good weather this could swing up against the deck and in rough weather by swinging it down in prolongation of the lower side of the coaming it would so deflect spray, etc., as to permit the hatch to remain open. For the same purpose air-ports on the side should have a ¼-inch lip around their upper semi-diameter to deflect the water from the deck above, thus preventing it from entering the port when washing down, or during an ordinary rain.

Boats of less than 100 tons should have but one large compartment, with an addition for pantry, closet, etc.

The Talbot class is an excellent example of arrangement of quarters for boats of this class. The only improvement that could be made would be a double fire-room bulkhead, and a hatch at the after bulkhead. At present the hot air from the fire-room bulkhead banks up at the after end of the cabin and remains at 110-120 degrees. In cutting a hatch it should be so located that no tables, desks or bunks are close under it, as a moderate amount of rain or spray down the hatch is accepted rather than close it, unless the damage to objects close by demands that it be closed.

The Morris having the most recently designed arrangement of quarters is very good, the principal drawback being that they are still too much cut up, too hot, and not well ventilated. By moving back her steering engine about two feet, and shifting her pantry to the starboard side, a free circulation of air could be obtained from the after state-room to the mess-room. This would allow the raising of the mess-room floor and lowering somewhat the cabin state-room floor; then by removing the wooden bulkhead between the state-room and mess-room an excellent airy room would be obtained. A curtain could be run across the forward end to be used when the bunk is made up. A hooded hatch at the after end of the junior officer's room and a hatch fitted with water-tight cover placed at the forward end of the captain's state-room would add materially to the comfort and make the ventilation nearly perfect. In these boats the petty officers' quarters are abaft the officers' quarters and forward of the forwar boiler. There is but one hatch. This ought to be fitted wit the square top ventilator described as fitted on the Talbot. O some of these boats a sort of temporary hatch hood has bee erected similar to this ventilator to keep out rain; but it is flims and cumbersome, and does not work except in port.

There should always be a double bulkhead between the fire-room and the living quarters with a lining of asbestos, or else a air space.

A double bulkhead with an air space would materially reduc the temperature in the cabin. This air space could be ventilate by having several small holes near the bottom of the after bulkhead, *i. e.*, the fire-room bulkhead and one at the top, the latte to be controlled by a shutter from the cabin so that it could b opened and closed at pleasure. A pipe to be fitted at this uppe orifice to run along under the deck and open at a convenien height in the outer casing of the smokestack. The air in th fire-room would then be driven by the blower between the bulkheads, and then between the smokestack and its casing, thus serving the double purpose of keeping the cabin and the outer stack cool. The amount of pressure thus lost from the fire-room could be regulated by the cabin shutter, even to shutting it off entirely when highest pressure was desired in fire-room. A few holes could be cut at the base of the outer casing if desired; but in five of our boats the casing is kept cool by draft from fire-room blower through small apertures over uptake. These cannot be regulated, however, and help in no wise to cool the cabin.

This scheme would greatly benefit the living spaces in all the boats. An additional device which would add greatly to the comfort of many of the boats would be to have a similar hole in the top of the forward one of the double bulkhead, and a pipe leading from this to the floor of the next compartment, or even under it. In cold weather this would render excellent assistance in heating and ventilating the living quarters. Then too, at sea in bad weather this would give excellent ventilation.

Crew's Quarters.—The best arrangement yet devised has been attained in the quarters of the Morris. The four chief petty officers are forward; the remainder of the crew are arranged in two compartments aft, the entrance to both being through the after conning tower. Practically all of the deck force is in the after one and the engineer's force in the other. The conning tower is oblong and contains a long narrow platform deck, supported by angle irons at the side, but leaving room for ventilation. This gives a nice dry place for the men in bad weather, and still ventilates both compartments. Forward of these two compartments is the galley with the closets and bath-room at one side. The galley should always have an opening into the crew's quarters. In one boat the only opening from the galley was to the deck overhead. No cook could stand it for long at a time, especially at sea, with the side air ports closed. Then too, with the cook to serve the table, the hoisting of the meals up one hatch, and then down another was a great source of inconvenience. By putting a windsail down the hatch there may always be a tolerable temperature, if there is an opening into the next compartment. The after conning tower being especially valuable for the purpose of ventilation should be large, oblong, and of very light material to keep down the weight.

Deck Fittings and Equipment.—Running around the boat at the height of her deck, or at the turn of the whaleback should be a heavy wooden guard to take the bumps unavoidably received from the decks, big ships, etc. This saves the bending and dishing of the thin steel side-plates. There should be nothing projecting beyond this guard, either above or below. Iron steps riveted on the sides of the boat are an abomination; they catch against the piles alongside of a dock, or cut a hole in a neighboring boat, when entering a slip, they serve no useful purpose, as the boats all have portable sea ladders.

The best deck railing seems to be a solid soft steel stanchion with three rows of wire about 1¼-inch steel galvanized. The advantages of solid stanchions are that they are neater, stand more bending, can be easily straightened, and are just as light as the hollow pipe stanchions. The stanchions should be held in the sockets by composition pins, kept well coated with black lead and tallow, and unshipped frequently to keep them working easily. Neat slip hooks can be fitted to both ends of the lengths of wire to keep the rail taut.

Boats.—The boats supplied to the Winslow type give excellent service. One is a wooden wherry, nicely finished, ordinarily for the officers use; and the other a metal boat, slightly larger, fitted as a life-boat with air-tanks running the length of the boat or both sides, under the thwarts. These tanks were punctured by accident at first, but a protecting board was run the length o the boat just over them so that heavy objects would not strike the air-tanks. The boat withstood many hard knocks during the war and proves very useful. The wooden boat had several holes punched in her at different times, but was repaired with a lead patch each time. Besides its greater durability and its buoyancy (owing to the air-tanks) the metal boat possesses the additiona advantage of not splintering. This is important as the torpedo boat would hardly part with her last boat; yet it must remain on deck in close proximity to a gun, or a torpedo. If the boats were fitted with a spritsail, and a rowlock at the stern which could be utilized for sculling, or for a steering oar, it would add to their convenience, and might in case of abandoning ship be a vital necessity.

The folding boats, possessing no good qualities, should be condemned.

As the number and size of the boats supplied are inadequate to carry the entire crew, a life raft must always be devised to carry those unprovided for. If the boat has gratings on her deck these can be utilized. If the boat should go down suddenly there would still be time to loosen and throw overboard gratings that would support the men. If a man also have on an inflated life belt he could survive many hours unless the water was too cold. If there should be time for preparation these gratings can be systematically built into a raft, and several empty deck chests placed on them to keep the crew partly out of the water.

In boats which are not fitted with gratings the experiment has been tried of having the deck chests water-tight, being fitted with tongue and groove lid, and rubber gaskets. On the outside a half dozen life-lines are fitted to be passed under the men's arms and secured. It was found that a moderate size deck-chest would support six men keeping their heads well out of water.

The life buoys fitted usually consist of three or four circular cork buoys, stopped along the rail about the forward and after towers, where most convenient. They are satisfactory in daylight, but lack a valuable point for night work; since there is no port fire to indicate its position after being thrown overboard. Several years ago a small cylindrical can fitted with calcium phosphide, and similar in a general way to the marker used to indicate the position of a Howell torpedo, was designed and fitted as an attachment on one of the torpedo-boats; it worked well but seems to have been abandoned in the equipment of the later boats. Objects on the surface of the water can only be seen a very short distance from the low deck of a torpedo-boat, and the chances of a man overboard at night are slim enough already, without reducing them to a minimum by discarding an apparatus that at least showed his approximate position.

At least two deck-chests are a necessity. One of these would be used for alcohol, and turpentine, or kerosene, and the other for deck fittings and equipment and deck gear of all sorts. It is usually bulging to bursting, and if room can be found for these chests, and a third one to be fitted on one side for a complete outfit of tools, it would add greatly to the convenience of the boat. In this respect the Winslow type was very well equipped. A kerosene can may usually be snugly placed in wake of a conning tower, leaving room for some paint in the alcohol chest. Heavy strap hinges should be fitted to the lids of the chests, with clinched fastenings; the ordinary door hinges with screw fastenings last only a few weeks. These chests should be small enough to go down a hatch so that they can be sent below in clearing ship for action.

An important accessory which has been added to many of the torpedo-boats after they were commissioned has been a shelf, usually just forward of the after conning tower, to which a vise could be secured for bench work. As there is a great deal of this work required on board it is necessary that a comfortable place for the work be found, if possible. The bench can be unshipped and sent below in clearing for action.

A vegetable locker of some sort is needed on deck; a perforated soap box will answer for a small boat; but the boats over 100 tons need a fixed, well-ventilated box placed aft where least in the gangway. The position on the Winslow was good; though projections from a dock or vessel would damage it slightly.

Mess and Chart Table.—A very light table with folding legs that could be temporarily placed on deck in good weather often furnishes a refreshing spot to take meals when the quarters below are very hot, or when underway with but one officer on board, and where the navigation would not admit of his absence from deck for a sufficient time to eat a regular meal. By utilizing signal mast or a torpedo tube as a point of support, a light boar with two folding legs will give a very satisfactory mess tabl This can be used for a chart table if the weather is fine; but if is bad the officer will be driven back toward the after tower, o even in that tower. A small folding shelf with a rack alongsid fitted in the after tower is always useful as a place for log bool charts, books and other aids to navigation, and is often the onl dry spot accessible from the deck. At sea in heavy weather a of the navigation is done from this end of the boat. If the chart that are to be employed on the run have all of the courses lai off, the bearings of the light-houses and principal points, fror certain convenient points along the track, and the distances lai off at five mile intervals, the chart can be folded and held in on hand, and the position of the boat approximately located withou using the chart table. When accurate position is required it ca be plotted on the table in the after conning tower or taken dow in the cabin. The heavy glass-covered chart tables placed o some boats are not at all appropriate.

Scuttle Butt.—Boats carrying twenty men and upward shoul have a properly built scuttle butt, holding 40 or 50 gallons o water, placed on deck, fitted with a cover that would keep ou the spray. This gives an ample supply on deck where it can ge moderately cool and aerated.

Water Tanks.—The difficulties of obtaining a supply of goo drinking water are very great. With station boats under 100 ton the question is not so difficult; the tanks are usually accessibl for cleaning and, as the entire supply of water is taken from a shore station, a boat starting out from a station with her tanks fitted and perfectly clean, will have good water till her return, provided the covers have been snugly set up. But as soon as we pass to the class of boats that are sea-keeping, being fitted with a distiller of some description, the question of water becomes a trying one. Only the question of water tanks will be taken up here, as the distiller comes under steam engineering. Tanks are made of copper, tinned inside, or of galvanized iron, lined with cement. If these tanks are all accessible when in place, they can be emptied and kept well cleaned when in port. But on account of the desirability of carrying as large a supply of fresh water as possible, some of these tanks are so placed that the living quarters must be abandoned, and a week consumed in getting them into an accessible position. The result is that those tanks soon get a deposit of iron rust and dirt that is but little noticed till the boat gets underway, when the water at once takes on a rich brown, and remains that way till the boat is again tied up to the dock. Then the slightest leak in a man-hole or hand-hole resulting from replacing the plate after last cleaning, and the sea from the bilge, or spray through the hatch salts up a tank. If to this is added the occasional salting that is given from the evaporator or distiller it is easily seen that fresh water is a dear article on board. A tank that is not accessible for cleaning by the force on board is of no use for fresh water for drinking or for the boiler.

Steering Engine.—The steering engine installed in the Porter class of boats is excellent, and gives perfect control, combined with lightness, durability, and handiness. The shifting from steam to hand is done with facility, and the radiation from the engine is not great. On one of the boats of the Winslow type an engine has been fitted that would probably be sufficiently powerful to control the Yorktown, while the heat caused the helmsman to faint away. Few men could take a trick at the wheel in rough weather without becoming seasick.

On the McKenzie class is fitted what is wittily termed the "Armstrong" system, being a tremendously heavy hand-wheel with cogged gearing which is slow and cumbersome in its action, and probably weighing more than a steam steerer fitted on the Talbot.

Criticisms on Ordnance.

In general terms our torpedo-boats are over-armed with torpedoes and under-armed with guns.

In the boats represented by the Talbot, the armament is two central pivot tubes and one 1-pdr. This is about all that the boat can carry. The 1-pdr. should be mounted on the forward tower instead of the after one, and a 6-mm. machine gun near the boat davits.

In class Q (100-150-ton station boats) the Cushing has three short tubes and three 1-pdrs., the Ericsson the same, the Morris two long torpedoes and four 1-pdrs., the Winslow class, three short tubes, four torpedoes, and three 1-pdrs. In all of these boats two long torpedoes and three 6-pdrs. would give muc greater efficiency.

In the sea-keeping torpedo-boats, class P (over 150 tons), tw long torpedoes, three 6-pdrs. In the destroyer class two lon torpedoes, one 12-pdr., five 6-pdrs. would be a suitable battery.

In the arrangement of battery the most desirable result woul seem to be to always place the most powerful gun on the fore castle, the others equally but unsymmetrically along the sides the boat, especially arranged for bow-fire. The gun mount shoul not sponson or project over the side; but a hinged grating shoul be fitted so that when swung out the gun captain would have platform for all-round fire that would only be limited by th smokestacks, conning tower, and the other guns. It is believe that the following tactical considerations will justify this selec tion and arrangement of battery.

When the torpedo-boat is fulfilling its proper function, and making a night attack upon a battleship or an armored cruise the battery would not be manned at all. After the torpedo wa adjusted and set to probable angle of fire two men only would b stationed at each tube, one to fire and the other to change th train if desired; or to fire in case the first man was disabled. A other men would be below deck except the officer and the ma at the wheel. After firing the torpedoes the boat would rely en tirely upon her engines to escape. The flash of the guns fro the torpedo-boat would only form a target for the rain of pro jectiles from the ship; good tactics would demand that they b abandoned and save the exposure of the crews.

The next case to be considered is that of a torpedo-boat pu suing another torpedo-boat, merchant steamer, or other vesse In this case it is desirable that the battery be placed especially fo bow-fire, if possible all guns firing directly ahead, so that the can be brought to bear in chase.

In the third case of a battle between the boat and another boa or vessel of equal or superior size and power. If the vessel about an equal match a head-on attack with the three guns firin would be made, until within a telling range, say 800 or 100 yards, when with a sheer of the helm 15 or 20 degrees the whol battery could be brought to bear and with their greatest effi ciency, while the target was greatest, *e. g.*, until the boat passe to a quarter bearing when an attempt to return under the enemy' quarter would be made. This might end in steering in a circle; if so the battery could still be employed with full effect. In case the enemy were a superior—a destroyer or a gunboat—the first effort would be to escape, the two after guns being employed in an attempt to disable him. Should it appear that escape was improbable, by turning about and charging at his bows and using these three forward guns the effect of the charge might be very demoralizing, as of course the discharge of a torpedo would be anticipated. Just when the torpedo would be discharged would depend upon the manœuvres of the enemy.

Attack upon a Superior.—It is not unlikely that the enemy would attempt to turn at 1000 yards and possibly attempt to increase the distance to avoid the torpedo. This then would probably offer a chance to fire both the torpedoes at 600 yards or less, at the broadside of the enemy, then sheering off his quarter. This should insure the destruction of the enemy, and possibly also that of the torpedo-boat; but the torpedo-boat would stand the better chance of living through the engagement, and assuming that they both went down, the crew of the smaller boat has the better chance of surviving, as crews can get overboard with the small boats, gratings, etc., immediately, and the suction from the sinking boat would be less. A good many men made their escape from the Furor when she went down off Santiago; this was probably an average case.

These rather hazardous tactics are believed to be superior to the slow and certain destruction brought on by the cool and deliberate shots of a superior pursuer, who, free from excitement, with little risk of accident, sinks or blows up the boat at his leisure with his forward battery. For any torpedo-boat or destroyer to deliberately come out and attack a superior vessel in broad daylight is mere bravado, and has proved a failure in many cases.

A recent example of such failures was the attack on the St. Paul by the Spanish destroyer Terror. The boat was promptly disabled, and again turned toward the port.

Of course every precaution should be taken to prevent these small craft from being placed in such perilous positions; but as shown in the manœuvres abroad, it is not unusual for daylight to catch them far from their home station, the prey of a passing scout. The first effort would be to escape into the nearest shoal, or port; but failing in this a final attack would seem better than slow destruction in a vain effort to escape.

In the tactics employed a strong point to be considered is th a man will fight better and shoot straighter, under the stimulu and excitement of a charge than when fleeing from a superi enemy. He has the encouragement of the offensive rôle, wit the advantage of a surprise, and yet the employment of his fu battery. If his pursuer be a gun-boat the latter probably coul employ only a very small part of his battery until he could tur his broadside; he might even reach torpedo range before the gu boat captain realized the importance of this, and turn only in tim to afford a broad target for the torpedo.

In the case where sea-going torpedo-boats are scouting for th fleet, especially in night formations where they represent the fee ers, their duty is to let no torpedo-vessel pass through their lin toward the battleships. The instructions in the Spanish wa when it was expected that the Spanish destroyers might be me were that they must be stopped at all hazards by any boat or boa discovering them. This of course meant a charge with all gu bearing that were possible. Three 6-pdrs. well manned in charge might stand a good show in such a fight against the pre ent battery of the destroyers as arranged abroad.

The shifting of the 1-pdr. in 100-foot boats from aft to forwar tower no one will dispute.

The selection of three 6-pdrs. is based on the following reason

(1) These boats being destined for sea trips of moderate lengt risk encounters with other large torpedo-boat destroyers an small gun-boats.

With this battery, the chances of disabling their opponents any of these classes might be good; with the present 1-pdrs. th would be small indeed. The effect of a 6-pdr. at 2500 yards under would probably suffice to wreck steering-gear and m chinery quite as effectually as the 12-pdr., while the probabili of a hit from any gun at a greater range than 3000 yards fro the lively platform afforded by these boats is small. Briefly it thought that the 6-pdr. covers the range of 1000-3000 yards well as the larger gun; while the 1-pdr. counts for but little b yond 1000, so that it is badly outclassed by the 6-pdr.

In the matter of weight the 6-pdr. counts as about 4-1. S that in the Morris type the second and third 6-pdrs. would b gained at the sacrifice of the third torpedo. In the Porter ty the same is true.

of the enemy, an allowance, such as half a ship's length or a ship's length as the case may be, would be as accurate as could be expected. An attempt to use the instrument at night on a torpedo-boat would be absurd.

Criticism of Certain Points in Equipment.

The allowance and outfit from this Bureau is so small that there are few points for discussion. The only important items are the compass, the electric plant, and the anchor gear.

The wire anchor cables on the Winslow class seem to have been too light, one boat having parted three cables while at anchor at Key West. The cables had been kept well covered with vaseline, and showed no sign of deterioration. The anchor for this type also seemed too light. The boats dragged often and one anchor parted at the middle of the arm. One of these boats, anchored in five fathoms of water used a 3½-inch Manila hawser, slipping and buoying when getting under way, and rode out a fresh norther with this tackle. These hawsers are much used by schooners, and when care is used to prevent chafing are of great service under special conditions. The ground tackle of the Talbot class seems to have worked well, and the method of hoisting the anchor by means of the steering engine is very neat, and works well, saving a second engine. In the Porter class the anchor-gear seemed to work well, but the high bow, and light draft forward makes these boats very uneasy at their anchors, requiring the second anchor for the slightest squall.

The standard compass in the different boats seems to have been well placed and given good service. The Negus compass on the Gwin class is satisfactory for the rough work required.

The dynamos and the electric installation have given good service. They are needed on all boats except class R, which, however, need to be wired so that they can connect to the plant in the navy yard, when at the dock. A small search-light has been fitted at the forward conning tower of a good many boats. While it is useful for navigation, its usefulness for war service is doubtful, and the objections rather outweigh its advantages, its weight and conspicuous position are especially objectionable. Nor is the use of this light on the destroyer to be recommended. An effort to hold it upon the fleeing torpedo-boat would be unsuccessful from such an unsteady platform, and the attempt to pick up a boat with it often leads to more confusion than success. This was found to be the case upon the blockade.

CRITICISM OF STEAM ENGINEERING.

All of the boilers so far employed in our torpedo craft have been of the bent tube pattern, nearly all of them differing from the Thornycroft principally in the fact that they have drowned tubes. The advantages of the two systems are so well known that it is needless to enter into the discussion here. Criticism will be confined to especial points brought out by experience in working them.

Winslow Type.—In general terms this boiler, instead of a single upper drum amidships, has two upper drums each over its lower drum. As originally designed, there was a pipe connecting the upper drums, with the result that at sea, with the boat rolling, one gauge-glass would show full and the other empty. To overcome this objection the connection between the upper drums was abolished, resulting in making the two halves independent, or in other words giving two small boilers instead of one large one. To supply them with feed water the feed pipe forked in the fire-room, feeding each side through a check in the upper drum. It was found almost impossible to feed the two sides equally through this forked pipe. The result was that the water was always tended badly; generally it was carried too high, with the resultant water in the cylinder, but occasionally it was lost entirely and on one or more occasions burnt tubes to show for it. It was not that the men were green or nervous; many men were tried in this billet on the different boats, old and experienced water-tenders were equally unsuccessful. Even if the water by careful watching can be successfully controlled it doubles the force required in the fire-room, for when using the ordinary type of boiler one experienced man tends water, gets out coal, and fires in the ordinary work of running around a station, when running at low speeds for cruising. If the boat is to make about her maximum speed the second man is needed to get out coal and to take a turn at the firing, but the water gives no trouble. Then the lower drums of this boiler were so small that only a boy could get into them, and the rolling of a tube by the force on board was impossible; moreover the efficiency of the boy's work was always doubtful. This boiler had a blank flange on the side of the pipe leading to the safety valve; the metal used to blank off the orifice was too light and springing slightly at the high pressures blew out the gasket and cleared the fire-room on several occasions. It is often the case that when the man is driven out of the fire-room by the bursting of a pipe or a bad joint that he will be able to throw open the furnace doors but not haul the fires. If there is a small port between the fire- and engine-room a hose can be played through this port from the donkey engine and thus wet down the fire till it can be controlled. The great importance of having safety valves and boiler and engine stops accessible from the deck is generally recognized, and most of our boats are so fitted. The deck valves should always be used after the run to shut off the steam, and frequently to insure their easy working.

Distribution and Service in Time of Peace.

This should correspond as far as possible with that which the boat would see in time of war. Consequently the station boats of the Talbot class should be distributed in the neighborhood of their cruising-ground in order to thoroughly familiarize themselves with the channels and coast in all conditions of weather and in all seasons. If possible, their crews should come from that district, and they should be allowed to remain there the greater part of the year. During a certain season they should be withdrawn to a more favorable climate for torpedo practice, manœuvres with the fleet, or such employment as might be demanded by the exigencies of the service. The assembly of them all at Newport in the summer would give a fine opportunity for concerted action with the fleet. Boats belonging to the district north of Philadelphia would do well to winter not further north than the Chesapeake Bay.

The larger boats designed to act with the squadron should conform in a general way with the movements of the large ships; that is, to visit our southern ports in the winter, and then assemble on the New England coast for combined practice in the summer.

The recommendations of the different commanding officers at the end of the war no doubt gave a very good idea of the needs of the boats as regards the complements of the crews. In general terms it was more men and higher ratings. It is difficult to see how larger crews can be accommodated in the crew space allowed. The only remedy is to avoid keeping crews on arduous duty such long periods at a stretch. Then, too, it must be remembered that most of these boats in the war did service calling for work beyond the scope of the boat and the crews as well. For work extending only over a short period their crews were sufficient. In regard to the rating, it is of course impossible to have each man a chief machinist or a chief gunner's mate; but the rate on deck should not be less than a seaman, and that in the engineer's force not lower than fireman, first class. In considering the fitness of a man for a torpedo-boat, it is important to consider his liability to seasickness. Very good men on larger ships sometimes prove to be of little value when the boat gets caught in a gale—a time when a man can be illy spared from his work. Men detailed for this service must be moderately young, of good habits, not liable to severe seasickness, intelligent and reliable. Any severe punishment inflicted is sure to react on the rest of the crew as well, since it brings extra duty on all of them. The opportunities for obtaining liquor are greatly increased as compared with the condition on board a large ship. The regulations now require that a man who has served on a torpedo-boat be marked as to his special fitness for that duty. By this means a corps of men specially fitted for this work can be obtained by the department, so that when it is desired to bring the crew of a boat up to its full complement, the seamen can be drafted from other duty to these vessels.

Officers.—During the war the detail of officers for torpedo-boats was one officer for class R (the Gwin type) and two officers for classes Q and P, there being no class O, or destroyers. This made the duty quite severe at times, but as there was a lack of officers, and none but regulars were desired on this duty, they preferred this arrangement.

The following temporary increase for the time the boat was in active service, either in time of peace or war, would be much better. On boats of class R, two officers; on both class Q and class P, three officers; on the destroyers, four officers. One of these officers should always be detailed for the engine-room, taking duty on deck, or excused from that, according as the commanding officer saw fit. In boats having more than two officers on board, this detail should be shifted after a time, say three months.

Experience on these boats, both on deck and in the engine-room, is most valuable for young officers, and when the boats are called out for active service in manœuvres, etc., the supply of young officers in the junior officers' quarters of the large ships should be drawn on to fill the complement of the boats. The experience in harbor pilotage, navigation, knowledge of harbors, etc., comes to them at an age when they are quick to learn, and responsibility sits lightly upon them.

Boats in reserve.—The question has arisen, What are we to do with our boats during the time that they are not needed on active service? Two propositions are to be considered and have been tried to a certain extent. One is to haul the boats up on a set of ways that is roofed over, and leave them there till they are needed for active work. A complete design for a large boat-house fitted with railway by which a boat can be hauled out, and a turn-table so that it can be switched to a side-track and another boat be hauled in, has been considered. Following out this idea, four boats were hauled out last year at the New York yard. The other proposition is to reduce the crews to the minimum needed to care for the boat, and moor the boat in a regular stall or pen so that no especial watch is needed to secure her safety. An officer is then placed in command of two or more of these boats, and inspects them regularly, testing the machinery at regular intervals and taking out the boat for a run at certain intervals to insure her readiness for service at all times. When boats are kept in this manner they are actually ready for service; and by drafting the additional number of men needed for the class of service demanded of the boat, she would be ready to leave in twelve hours, or even less time. The most important men are thoroughly familiar with their duties, and can quickly instruct the others. This has been tried on some of the boats and seemed to work satisfactorily.

If the boat be on the ways, and it is desired to use her, she is put in the water, and officers and crew are ordered to her; orders are given for a dock trial, and then follows a long itemized requisition for repairs needed before the boat is ready for service; steam joints are not tight and need re-packing, the condenser leaks, or the feed pump needs overhauling, or the water-tanks must be cleaned out, etc., etc., and the boat does not get away from the navy yard for weeks. There is no one to blame. Time and disuse will always bring about some such condition, and then if on top of this there has been any neglect in the precautions to preserve the boat when she was laid up, the trouble is increased many fold. A court of inquiry may follow, and after a long search may, or may not, find where the fault was; but this will not help the boat. She is finally hustled away from the navy yard, though her men have not yet learned all their duties. If she escapes the discomfiture of an early return she will be fortunate. The new officers blame the navy yard work, and the navy yard either blames the people from whom she was received, or says that they do not know how to run her.

The two arguments in favor of hauling her out were: (1) that it was more economical and (2) that the men were needed elsewhere.

In regard to the economy, if the bill for repairs be examined after the boat has left the navy yard it will no doubt about equal the cost of maintenance of a reserve crew on board. Moreover, if there had been a need for this boat she could have been used at once if kept in reserve, and can be counted on as actual offensive power available.

In regard to the need of the men elsewhere, a detail of from six to ten men will be sufficient for each boat, so that the laying up of one big cruiser would suffice to maintain fifty torpedo-boats. It is admitted that the rates of these men would run a little higher than the total of a crew of a large ship.

From the experience that has been obtained with our boats, it is thought that the following detail would suffice for all boats:

A chief machinist and a machinist first-class for the engine-room, an oiler for each engine, one water-tender for the fire-room; if there is more than one boiler, an extra man in the fire-room for each additional boiler. In the deck force would be needed a chief gunner's mate, a quartermaster first-class, and for class P a seaman.

When these boats are in reserve they should be arranged in groups of three or four, placing as far as possible sister boats in the same group. A lieutenant to be placed in charge of each group. His duties would be to keep the group in running order and to take out each boat at least once a month for exercise. Target practice at full speed with torpedoes, and with the battery, to be held as often as circumstances would permit. The Navy Department requires that the former be held at least once a month, and the latter at least once a quarter. In fine weather these exercises could be held very much oftener. The boat selected to go out for practice should carry an additional crew taken from one of the other boats, thereby giving them double the practice, and lightening their duties. It is thought that the best results are undoubtedly obtained by keeping the boats in commission and requiring the men to live on board them. A man never takes the same interest in a ship or boat unless he lives in her, nor does he form a proper sea-habit. If he live in barracks on shore, the sharp contrast of his first night at sea, or his weeks at some other port than a navy yard, makes him dissatisfied and inefficient. The boats are comfortable enough when at the dock; and when at sea the man can sleep better in his accustomed bunk, in fact is at home on board, which the barrack's man is not.

Drills.—The minimum number of drills and exercises each quarter having been established, it is all important that there be an annual mobilization of this fleet at one of our important bases for a complete and thorough series of exercises in co-operation with the fleet. Newport offers the best rendezvous for battleships, cruisers and torpedo craft; while its deep water and moderate tides and land-locked coves offer fine opportunity for practice. Night attacks should be made upon the fleet while at sea protected by destroyers, and upon single vessels in the harbor; tests as to relative visibility of different types of torpedo-boats would show the value of the station boat; urgently needed training of the firemen to prevent the sudden flare from the smokestack when the near approach has begun; careful training to enable the boat to get within torpedo range with full pressure of steam, and yet not lift the safety valve. Thus a more perfect knowledge of the value of the torpedo-boat will be obtained by the officers on the battleships. The naval officer possesses the happy faculty of forgetting his anxieties and hardships; so that already the strain of the first few nights on the Santiago blockade are but faint memories. The statement is too often heard from officers that have known better, that "torpedo-boats don't amount to much; they did nothing during the war. We tested their attacks at Key West."

What different work would the blockade have been had we lost a battleship during the early days of the blockade by a night sortie from Santiago. There were a large number of phantom torpedo-boats chased and sunk as it was, but the memory of the sudden destruction of a battleship would have made them legion.

The writer does not believe that the torpedo-boat can perform miracles (especially without considerable exercise and practice beforehand), but these boats have an important rôle in naval warfare, in which they have been, and will be, employed with telling, and at times, demoralizing effect.

In conclusion, we need three types of torpedo vessels to meet the conditions which will arise in case of war, and we need trained crews to render them efficient in time of need. The former rests in part with our national legislators; but the latter can most efficiently be maintained by keeping a nucleus on each boat, and thus keeping each boat ever ready for service.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE AUTOMOBILE TORPEDO AND ITS USES.

A DISCUSSION OF THE TORPEDO POLICY BEST ADAPTED FOR THE UNITED STATES NAVAL SERVICE.

By LIEUTENANT L. H. CHANDLER, U. S. Navy.

MOTTO:—"In a word, the torpedo has brought into the Navy a fresh zest, a new romance, and possibilities more brilliant than were ever existent before its adoption."—*Torpedoes and Torpedo Vessels, Lieut. G. E. Armstrong, R. N.*

1. In opening this paper, the writer may as well admit at once that he is an enthusiast on the subject of torpedoes, but he hopes that he is a moderate one and that he fully realizes the limitations of the weapon. He has always been a friend of the so-called "freaks" of the navy, being of the opinion that each of these is of great value under certain conditions and of almost none under all others. What is considered to be the proper field of the torpedo will be pretty thoroughly demonstrated as this paper progresses.

2. The endeavor will be made to show under what circumstances and by what means torpedo warfare can be best carried on by our service with a good fighting show of success. It has seemed to the writer that there is too little literature extant on this subject from the thinkers of the navy, and this paper is prepared in the hope that it may bring forth arguments from those having knowledge and experience in torpedo matters, so that the interest of the service may be excited and a better appreciation of the subject gained by all. Doubtless in the course of the article many old ideas, not original with the writer, have had to be dressed up and dragged to the front again, but the subject in hand has received so little discussion of late in our

service and the advance made in torpedo material has been so great that there is an evident need for a further stirring up of minds in regard thereto, and this fact must be accepted as an apology for the reproduction here of many ideas that have been often presented before.

3. Throughout this paper the object has been to consider the matter temperately and to discuss only those methods which promise rather more than a mere possibility of success. While arguing from this standpoint alone it is not meant that unusual exertions under special circumstances may not accomplish results with conditions far more unfavorable than those in any of the situations here considered. It is thought that they would, but the effort has been to avoid making claims for possibilities of success except where there are very good grounds for believing such success to be more than likely. When a new weapon is introduced it is frequently killed by the exorbitant claims of its friends. It may be put down as an axiom that the difficulty of using a weapon successfully increases directly (and perhaps in a higher degree) with the deadliness of its effect. Such being the case, the frequent claims that some particular mechanism for handling high explosives in warfare is going to revolutionize present methods inevitably redounds, as do all excesses, to the detriment of the device in question. The writer has here tried to avoid this mistake.

4. Torpedo-boats and torpedoes are essentially a part of the harbor-defense system of this country. Unlike the powers of Europe, our coast is too far from an enemy's shores, with a possible exception, to make the passage of torpedo vessels from one to the other for hostile purposes a very likely occurrence. It is asked that this statement in regard to the proper sphere of action of torpedo vessels may be accepted for the present as true, for the sake of argument, and the reasons for this belief will be developed at length as the paper progresses. In relation to it, it may be said that the oft-made comparison between the torpedo-boat and the highly-bred race horse is an apt one. Each is the highest type of its race, each gives the maximum speed attainable by any of its kind, each has to be carefully groomed and cared for at all times, but more especially just prior to trial; each will be quickly broken down by constant driving over rough ways, and conversely each will be quickly ruined by lack

of proper exercise, while each requires the most expert knowledge on the part of the handlers.

5. But why carry the comparison further? Does not every point advanced go to show that the sole legitimate duty of the torpedo-boat is to choose its own time and weather, and, in company with others of its own kind, to dash forth from its own home port to an attack upon hostile ships within easy striking distance, as would be those of a blockading force?

6. The consideration of the question of torpedo warfare will be taken up in this paper under the following heads:

A. The limitations of torpedo-boats and of their weapons.

B. The method of approach and of attack.

C. The stationing of the flotilla in time of war and in time of peace.

D. The care and preservation of the boats in war and in peace.

E. The proper training of the personnel.

F. Circumstances under which the flotilla may be of assistance to the fleet.

G. The question of ship's torpedo-boats.

H. Modifications of the preceding arguments to make them applicable to torpedo-boat destroyers.

I. The use of torpedoes on board vessels not specifically designed therefor.

J. The use of boats at a distance from their base. When possible and how best accomplished.

K. Modifications of the theoretically perfect system made necessary by our lack of boats, officers and men.

L. Types of boats and their standardization.

M. Types of torpedoes.

N. The bearing upon the above statements of the lessons of the war with Spain.

O. General summing up.

A. THE LIMITATIONS OF TORPEDO-BOATS AND OF THEIR WEAPONS.

7. As far as the boats themselves are concerned, the constant hard running incident to continuous cruising has always been found to disable machinery and render stale the personnel. On the contrary, boats can no more be laid up without a crew on

board and then be suddenly called into service and give effective results than can a watch be laid away motionless in a drawer for a long period and then be expected to run accurately when wound.

8. The ideal condition of boats for service is to keep them always in full commission, with full complements of officers and men on board, employed constantly near their base in short runs and torpedo practice. This keeps boats in condition, crew fresh and well instructed and weapons in good shape.

9. The introduction of the gyroscopic steering gear for torpedoes has done much to improve the accuracy of the weapon, but it has one great disadvantage. If not in perfect adjustment, this gear is worse than nothing, as it renders a miss certain. No gyroscope can be adjusted or even examined to see whether it is in adjustment or not, except upon the most stable platform. It is doubtful if it could be done on board even the largest ship, except under exceptional circumstances. Vibration from auxiliary machinery would probably be sufficient to render the adjustment very difficult, if not impossible. So it would seem that the gyroscopic steering gear can only be satisfactorily used when it can be taken ashore and adjusted or frequently examined for adjustment.

10. Torpedoes kept in tubes and ready for use on board torpedo-boats, as they must always be in war time, are subject to constant deluging with salt water when at sea, and it would seem that the chances of a successful run from a boat which had been long away from port would be very greatly reduced on that account.

11. For these reasons torpedo-boats cannot, except under exceptional circumstances, be called upon to operate far from their base.

B. The Method of Approach and of Attack.

12. This being one of the most important questions in relation to torpedo warfare, seems nevertheless to be one of the least discussed, at least in our service, and one in regard to which fewer fixed ideas and opinions prevail than almost any other. The German method seems to have many advantages. In this a "section boat" leads a "section" of six other boats in a wedge formation, the section boat at the apex, the two boats, one on each

quarter, forming the first "division," the two at the rear end of the right flank the second "division," and the two at the rear end of the left flank forming the third "division." These boats advance to the attack so close together, the section boat leading, that a man may step from the bow of one boat to the quarter of the one next ahead. Each follows the motions of the boat ahead, changes of speed being signalled by flashing a small lantern at the stern of each boat, so arranged that the light is thrown down into the wake. The wash from the screws tends to keep the boats from touching the sterns of their leaders. When sighted by the enemy, or at signal from the section boat, the boats spread out on each side and deliver the attack from seven different points of the compass, the section boat making a direct attack. Prior to the attack, a route of retreat is agreed upon to diminish the chances of collision.

13. The writer may say at once that he sees no better method of attack than this, then proceeding to criticise and discuss its leading features. Any scheme which involves preconcerted attack at the same moment by a number of vessels is difficult, even in the day-time; and at night, especially under the circumstances of weather when a torpedo attack should be made, it is almost certain that some of the boats would be ahead of the others. What is the best method of reducing this error to a minimum?

14. The first thing is to adopt the method of approach which shall keep the boats together as long as possible without subjecting them to the fire of the adversary while grouped or sacrificing the advantages of a scattered attack, while at the same time, the time element is eliminated to the greatest possible extent. The formation should be such as to permit the quickest possible systematic opening of order should the flotilla be discovered while grouped. The formation should be that which will enable the senior officer to retain control of all its units to the last moment possible while engaged in that hunt for his adversary which it will often be so difficult to bring to a successful termination.

15. It seems to the writer that the German wedge offers the best answer to all the above requirements. In it the senior officer retains control to the last moment possible, open order position is taken by the simultaneous action of all the boats, and

they can therefore more quickly spread, if detected while grouped, than from almost any other formation.

16. The ideal attack would, of course, be that in which the attacking force discovers its object without itself being at once detected. The approach being made at a speed sufficiently low to prevent the rolling up of a mass of foam under the bows and to enable the fires to be so handled that there will be no masses of flame bursting from the funnels, the section boat would continue towards the enemy at the same speed, changing her course if necessary; the signal for dispersion would be given, and the boats would spread out into positions say two points apart, at varying speeds, the flank boats moving most quickly. They would then continue the approach, the section boat gradually working up her speed, after allowing a time interval of short duration to elapse to give the others a chance to place themselves, and when discovered it would be full speed at once for all.

17. Of course if the section is discovered before it has opened out, full speed must be attained at once, and the wing boats would only spread out enough to break up the grouped target. In this connection a suggestion recently made by Lieutenant A. P. Niblack, U. S. Navy, might be adopted with probable success, it being for the boats as they spread to drop overboard phosphorescent buoys to tempt the fire of the enemy. A few such marks judiciously dropped in the open sectors as the boats cross them would probably prove a very strong temptation to the captains of the secondary guns.

18. In relation to the method of delivering the fire, it may be said that the introduction of the adjustable gyroscopic steering gear has added greatly to the chance of a hit. With, for example, two central pivot tubes on the fore and aft central line of the boat, these should be set one broad on each bow. The steering gears of the torpedoes should be set to bring them both to run parallel to the course of the boat at the moment of firing. Then the commanding officer has only to steer his boat for the point at which he wishes his torpedoes to run and to fire them at the right moment. Two torpedoes will thus be simultaneously discharged in directions ninety degrees apart, one of which will make a turn of forty-five degrees to the right and the other of the same amount to the left, and they will then run parallel at quite a distance apart. The advantage of such a method of fire over

anything possible prior to the latest improvement of the gyroscope is very apparent.

19. The return from the attack is not important. The boats should be saved if possible, of course; but no one can go out expecting to return, and any man who lets that idea seriously enter into his calculations had better stay at home altogether. Let it be agreed as to how the boats will turn for the retreat after delivering their fire, in order that the chances of running into each other may be diminished, and then let the boats all make the best of their way to a rendezvous independently. This spot should be as near the enemy as possible, while protected from him, and the boats should stand by there to help the injured until all are either in or given up.

20. The question of attack by two or more sections renders the matter still more complicated. The sections should remain together as long as possible without sacrificing any other advantages, and then the time element must be taken into account to secure simultaneous attack. The difficulties are manifest, and they can only be overcome by officers whose boats are a part of themselves and whose knowledge of each other and of the waters in which they are operating is so perfect as to be instinctive.

21. A question of importance to be considered is the avoidance of the enemy's picket boats, and here we have something which must be left more largely to the dictation of circumstances than almost any other part of the tactics. Whenever possible, the attack should be made from the quarter where it would be least expected, from the seaward if possible. Unfrequented and little known channels should be used to attain a position on the outer side of a blockading fleet, thus enabling the attack to be delivered from the off-shore side. Where practicable, the cutting of such channels at proper points should be made a part of the defenses of every harbor. At times it would, perhaps, be possible to have the attack delivered by a section from some other port than the one off which the enemy is lying, or by two sections, one from within and another from without simultaneously. An attack from off shore, assisted by a feint from the harbor mouth to distract the pickets and the enemy's fire (to be turned into a real attack if the chance occurs) would give great chances of success.

22. Failing in the chance to attack from an unexpected quarter, it would probably be best to make a few preliminary attacks to

destroy the picket vessels by gunfire, every such feint to be turned into a real attack if the chance comes. An effort might be made from within in weather in which the enemy would find it impossible to handle his small picket vessels.

23. Another method of attack proposed is to have the section find the quarry and then steam around it in column, boats dropping off the rear end at intervals, until all are distributed, when the attack is to be made. Here the section escorts each boat to its station and the time consumed in doing so would be relatively very great and the chances of discovery much increased. It would be impossible of accomplishment were the boats discovered as soon as they found the enemy, and the section would then be left without a plan.

24. Of course, the German wedge might be changed into a column, if desired, but the arguments for so doing are not clear. It does not seem likely that the boats in the wedge could be kept as close together as has been indicated, when operating under service conditions, and the danger to the bows of the boats from the twin screws of their leaders would be very great. The Germans make great use of single-screw boats, and it would be easier with them. It is also probable that the stern lights would have to be extinguished at least as soon as the proximity of an enemy was discovered.

25. The nomenclature here adopted differs somewhat from the German, and it may be well to give the following definitions of terms which are consistently used in this report:

(a) The " flotilla " includes all the torpedo vessels of the navy.

(b) A flotilla " section " is a squadron of seven boats acting together as a unit.

(c) A coast " district " is a section of the coast to which one or more sections are assigned.

(d) A district " base " is the depot and refitting establishment of the district.

C. The Stationing of the Flotilla in Time of War and in Time of Peace.

26. In discussing this question, the war basis will be first taken up, after which will be considered the changes that it seems most advisable to make in that disposition consequent upon the arrival of peace.

27. From his personal knowledge of torpedo-boat duty, the writer is very positively of the opinion that it is too complex and its wants too immediate to enable it to be properly handled under the present system, where the boats are, for various purposes, under the control of several independent bureaus. In the way of stores, the very smallness of their wants makes them subject to being overlooked in the bureaus, and such a failure will very largely ruin the efficiency of a boat. The flotilla should have some officer in the department, preferably in the office of the Assistant Secretary, who can take entire charge of the boats. He should be a man who has had large practical experience with torpedoes and torpedo-boats, and who is interested in his work and zealous for the advancement of the particular weapon with which he is concerned. All correspondence, requisitions, etc., relating to the flotilla should come to him, and he can then exercise the personal supervision over them which is now felt to be nobody's business. In other words, the flotilla must have a head. It is not desired that this head shall be so placed as to be antagonistic to the different bureaus; on the contrary, there should be chosen for the place an officer who will have tact enough to enable him to make himself regarded by each of the chiefs of the various bureaus in the light of an assistant in his own particular bureau, one who will take up the very small, but very important, details of the flotilla.

28. So much for the departmental organization of the flotilla. As far as the division of the torpedo force is concerned, the coast should be divided into districts, and the following is suggested as a most appropriate division:

No. of District.	Name of District.	Limits of District.	Base.
1.	Maine.	Eastport to Portland.	Rockland.
2.	New Hampshire.	Portland to Rockport.	Portsmouth.
3.	Massachusetts.	Gloucester to Provincetown.	Boston.
4.	Rhode Island.	Provincetown to Fisher's Id.	Newport.
5.	Long Island Sd.	Fisher's Island to New Haven.	New London.
6.	New York.	New Haven to Barnegat.	New York.
7.	Delaware.	Barnegat to Winter Quarter Shoal.	Near mouth of Delaware Bay.
8.	North Chesapeake.	Winter Quarter Shoal to Cape Henry and Chesapeake Bay, north of Thimble Shoal.	Yorktown.

No. of District.	Name of District.	Limits of District.	Base.
9.	South Chesapeake.	Cape Charles (Hampton Roads) to Cape Hatteras.	Fort Monroe.
10.	North Carolina.	Cape Hatteras to Cape Romain.	Wilmington.
11.	South Carolina.	Cape Romain to Port Royal.	Charleston.
12.	Georgia.	Port Royal to St. Mary's Entrance.	Savannah.
13.	Florida.	St. Mary's Entrance to Cape Canaveral.	Jacksonville.
14.	Key West.	Fowey Rocks to Dry Tortugas.	Key West.
15.	Tampa.	Key West to Apalachicola.	Tampa.
16.	Pensacola.	Cape San Blas to Ship Island.	Pensacola.
17.	Mississippi.	Ship Island to Atchafalaya Bay.	Near mouth of Mississippi R
18.	Galveston.	Atchafalaya Bay to Rio Grande.	Galveston.
19.	Porto Rico.	Porto Rico.	San Juan.
20.	Cuba.	Cuba.	Havana.
21.	Puget Sound.	Cape Scott (Vancouver Id.) to Westport (Washington).	Bremerton.
22.	Oregon.	Westport to Cape Blanco.	Astoria.
23.	North California.	Cape Blanco to San Francisco.	San Francisco.
24.	South California.	San Francisco to Point Conception.	San Francisco.
25.	San Diego.	Point Conception to the Rio Tia Juana.	San Diego.

29. Should Cuba be annexed, it would be advisable to have a North Cuba district, base at Havana; and a South Cuba district, base at Santiago. In the future the carrying out of the system here indicated by the formation of districts in the Hawaiian and Philippine Islands would naturally follow, but for the present discussion the division above indicated is sufficient.

30. To each coast district should be assigned a section of the flotilla, consisting of at least seven boats, say one destroyer and six boats. For this there would be required 175 boats, which is not an excessive number towards which to build.

31. The commanding officer of the destroyer in each section should command the section, and only officers who have had practical experience in torpedo work and who are believers in the weapon should be selected for this duty.

32. The section commander should also command the district base. The purpose and nature of these bases are indicated in

another section, and here it may only be stated that they should never be located at navy yards. Their great object will be set aside unless the section commanders can absolutely control them. A very few watchmen and laborers would need to be employed at each base.

33. The daily occupation of the flotilla in time of war is evidently a question which does not need discussion except as to tactics, and that point will be found covered in another section. Let us now proceed to the discussion of the stationing of the sections of the flotilla in time of peace.

34. To avoid sickness from climatic influences, the boats should come north in summer and go south in winter. This could be easily done without breaking up the flotilla sections by ordering two or more of them to the same district of coast for the season, each section to act as a unit, but the senior section commander to control them all.

35. Then, for purposes of instruction of personnel and preservation of material, section commanders should be required to keep their sections busy in legitimate work. Other senior officers should not be permitted to interfere, except at such times as the department should order one or more sections to report to the commander-in-chief of the heavy fleet for exercises.

36. It is not thought necessary to go into further elaboration of the details of this scheme. Its many advantages are manifest. Among them may be mentioned the ease with which two or more sections can generally be brought together. It would also be possible in many cases for one or more flotilla sections to deliver an attack from seaward upon a hostile fleet operating in another coast district.

37. As to the plea, which will doubtless be advanced, that we will never have enough boats for this division, the writer would say that any scheme is better than no scheme. He believes that the one here laid down is a consistent outline of the best methods of using the torpedo for coast defense, which he believes to be its legitimate field, and does not think that the number of boats mentioned will be in excess of the number that our navy will finally have. As soon as the boats now building are finished, the many voters employed in their construction will be certain to bring their influence to bear upon Congress for the purpose of having the construction of more boats authorized.

D. The Care and Preservation of the Boats in War and Peace.

38. The arguments advanced in the preceding sections make it almost unnecessary for the writer to state that he is most strongly of the opinion that there is but one way, either in peace or war, in which the torpedo-boat flotilla can be kept ready for duty on short notice, and that way is to keep all the boats constantly in service. The least dangerous modification of this method will be considered later in this paper, but for the present the discussion will be confined to the ideal condition indicated, that where all the boats are in commission with full complements at all times.

39. At the base of each district there should be proper wharves and storehouses. Each boat should have its own wharf and its own storerooms, to which the commanding officer should have the key. Thus each boat could have her supplies at hand, and yet the present overcrowded condition of the boats in regard to stores could be avoided. There should be barracks for the men, who should ordinarily live there, and a separate dormitory for each boat, with either separate messes or a common mess for all, as circumstances might show to be best. A separate building, with sleeping apartments and accommodations and mess arrangements for all the officers of the section should be arranged. Then, as in almost all foreign torpedo services, the officers and men could live under sanitary conditions, making such daily runs as might be desired for exercise, and living on board the boats for short periods during more extended runs to the limits of the coast district.

40. At each base there should be a coal shed with the best quality of coal in bags, so arranged that it could be carted to the wharves alongside the boats ready for speedy coaling. Fresh water connections should be established alongside each boat. A general storehouse at each base should also be maintained, where standard stores of all kinds should be kept on hand, together with a supply of such special stores as might be needed for each particular boat. This storehouse should be able to meet at once every possible want of each individual boat without the necessity of waiting for the accomplishment of a purchase. Every system of accounts or requisitions which in

the slightest degree retards the supply of the boats should be changed at once. Torpedo-boat officers cannot keep books and handle returns and reports except to the extreme detriment of their legitimate work. A small machine-shop capable of doing torpedo repairs of moderate dimensions should be established at each base, where work could be done by the force of the boat needing it. It is thought that advantages would accrue by having the machinists who run the engines do as much as is possible of the repair work upon them. At each base there should be a dock or railway capable of taking from the water the largest destroyer, even were she in a sinking condition.

41. With the facilities herein recommended, commanding officers could with ease gain every sort of experience necessary, run their boats continuously to keep them in proper order without using them up, could oversee and direct such repairs as became necessary, and would have every facility for torpedo and gun practice.

E. THE PROPER TRAINING OF THE PERSONNEL.

42. We must bear in mind the delicacy of the mechanisms involved and the extreme difficulty of the service upon which the officers and men of the flotilla are to be sent. Each torpedo is an individual whose whims and fancies are only known to him who has watched and lived with that individual weapon for many days. Each boat is an individual, and a very highly strung one too, whose eccentricities of helm and general action must be learned by experience. Each engine is an individual whose peculiarities can be known only to those who have spent days and nights with it under all conditions. The cracking of some obscure and unnoticed valve, when the critical moment comes, may set at nought all efforts. The compasses all are individuals, many of which do not come far from being invalids (such uncompensated errors as 50 degrees are frequent), and only by the greatest familiarity with his own particular one can an officer hope to guide his boat aright through the darkness, rain or fog through which the attack should be delivered.

43. Imagine, then, an officer and crew sent aboard a strange boat to go out as soon as possible to the attack in the darkness and storm. The officer has no confidence in his compass, and

if that boat has just come from reserve, his lack of confidence would undoubtedly be justified. The engineer's force are in constant doubt as to what they are doing, which is not conducive to steadiness on the part of men moving among such machinery as is found in the engine and fire-rooms of a torpedo-boat. The deck force have no idea as to what the torpedoes will take it into their heads to do when fired.

44. Is it right to so place officers and men who are willing and eager to risk their lives in the most dangerous form of attack known to modern warfare? Is the general feeling of strangeness and doubt which must prevail under these circumstances the proper atmosphere in which to send men out to such duty?

45. The answer is plain. Only after long familiarity with every detail of the individual boat and her outfit, the equipment, and armament, can officers and men justly be called upon to set forth upon that journey from which no man who starts can ever reasonably expect to return.

46. Therefore, most emphatically, boats should be kept in commission with officers and men on board at all times, and upon the outbreak of hostilities the greatest caution should be exercised that changes in the personnel may be reduced to a minimum. Exercise runs should be of almost daily occurrence, and should be taken under all possible conditions of weather, etc., at night as well as in the day-time. This also should be done in sections as for attack, and separate sections should be exercised in delivering the attack at a certain point simultaneously, as it would have to be done in actual service.

47. The question of training of officers as local pilots in the waters in which they are to operate is of the utmost importance, and by the plan here proposed officers could gain that knowledge to the utmost, each for his own district; and then in case of concentration on any particular district, there would always be competent pilots to lead the formation.

48. The torpedo-boat sections should also be frequently exercised with the heavy fleet, being placed temporarily under the orders of the commander-in-chief for that purpose. These exercises should include night attacks upon the fleet under service conditions and also co-operation with the fleet against an enemy.

F. CIRCUMSTANCES UNDER WHICH THE FLOTILLA MAY BE OF ASSISTANCE TO THE FLEET.

49. If a fleet leaves a blockaded port, or one threatened by the approach of an enemy, the torpedo flotilla could probably be of material assistance. Several boats could hang under the shelter of each large ship until the moment arrived for action. It is doubted, however, whether the boats would be able to get far in the day-time, even under such circumstances; they are too easily destroyed. Every argument would point to delivering an attack from a home port against a foreign enemy in pilotage waters at night, and then the boats would stand an excellent show of accomplishing something. In such a case, however, the plan of action must be clearly understood, and by the gun-pointers of the big ships as well as by their officers, for under the best of circumstances the torpedo-boats will be very apt to receive an occasional shot from their own ships.

50. Operations with the fleet at a distance from the base, it is believed, could only be successfully carried on under the conditions mentioned in section J, and the results of such operations are matters of grave doubt to the writer.

51. Any attempt to make the boats a part of the heavy squadron for general purposes will surely result in utter failure and the ruin at least temporarily of the boats. When called upon for the supreme test they will be found wanting, in all likelihood, and the blame will fall upon those officers and men who are risking their lives and reputations in this most hazardous calling instead of upon those in high places who order such action.

52. The flotilla could be of undoubted service in aiding the fleet to repulse an enemy who was endeavoring to force an entrance into a harbor. The tactics for this purpose would depend so much upon the topography and hydrography of the port that no general rules can be laid down, other than that the fullest advantage must be taken of all favorable points.

G. THE QUESTION OF SHIP'S TORPEDO-BOATS.

53. The tendency in our navy of late has been to do away with this form of launch, and this the writer believes to be a mistake. These boats can do what the regular flotilla cannot: they can go with the fleet under all circumstances, ready for use if the con-

ditions proved favorable. They can deliver a very fair attack under certain conditions, which would be not unlikely to occur, and they would be invaluable as picket launches, etc.

54. The boat adopted for this service should be as fast as may be without sacrificing her seaworthy qualities, should be as large as can be handily carried and gotten in and out, should have a single central pivot tube on the fore and aft line on deck, and should not be called upon to carry air compressors or other unnecessary machinery. The torpedo should be placed aboard her ready for firing.

55. It would be an undoubted advantage for every fleet to have with it a torpedo depot and repair ship such as the English Vulcan, which would be a supply and repair ship for all torpedo material, and could carry half a dozen torpedo boats of a higher type than the regular vessels of war could accommodate.

56. Very stringent regulations in regard to the use of ship's boats should be passed. They should be exercised with their crews at every possible opportunity, and at the same time their use, even occasional, as steam launches should be most strictly forbidden.

H. MODIFICATION OF THE PRECEDING ARGUMENTS TO MAKE THEM APPLICABLE TO TORPEDO-BOAT DESTROYERS.

57. Fundamentally, the destroyer is built to cruise with and to act as an adjunct to the fleet, to repel torpedo-boat attacks, and to destroy the attacking boats. The writer finds it a little difficult to see how there is much chance for them to perform these legitimate duties in our navy. The type was called into being in Europe where the countries are so close together that a blockading fleet could easily take the destroyers with it, which would of course be an enormous advantage. The destroyers could there habitually cruise off the enemy's coast. On our part, with the possible exception of the English possessions to the north and of certain nations of no military importance to the south, our destroyers could never do this. The possibilities of getting them across the ocean in condition to work are practically nil. In the same way it seems very unlikely that they would ever be called upon to combat any boats of a higher type than those carried by big ships, for how are others to be brought to our coast?

58. Admitting that this argument is sound, our own destroyers will then be used more as torpedo-boats than for their theoretical purpose. They become with us simply torpedo-boats of a greater range of action, but that range is not great enough to take them far from their bases. Their tactics may then be considered as the same as those of the boats previously considered, only with the distance scale and that of ability to keep the sea in bad weather somewhat increased. The destroyers in a certain locality could be brought together to deliver an attack upon an enemy off the coast under circumstances of weather and distance which would bar the smaller boats from action, and such is believed to be their proper sphere of action in our navy.

I. THE USE OF TORPEDOES ON BOARD VESSELS NOT SPECIALLY DESIGNED THEREFOR.

59. The writer believes that torpedoes in unprotected positions on board ship are a source of danger great enough to more than compensate for any possible advantage that might accrue from their presence. On board vessels built for the special purpose this risk is a legitimate one which is of a necessity to be run, but it should not be taken on board larger ships except under very exceptional circumstances.

60. If a vessel be large enough to carry a couple of submerged tubes, torpedoes then become weapons which may be invaluable; and they should certainly be installed, for their presence in no way constitutes more than ordinary danger. In this connection it may be remarked that with such tubes it will be essential that the actual firing be done, without any intermediary, from the pointing station on deck, and also that the captain of a ship in action cannot possibly give the matter sufficient attention to do it himself. An experienced torpedo officer should be stationed where he can himself fire the torpedo at the proper moment, as shown by his own judgment, after having been notified by the captain that an opportunity for the use of the weapon is expected. The retention of above-water tubes and torpedoes without war-heads on board regular war vessels for purposes of instruction and practice only, of course, does not affect the point at issue.

61. Under exceptional circumstances, where a weak vessel must face overwhelming odds, in defense of her own home ports

for instance, it is recognized that the torpedo is the only weapon which can place the weak vessel on an equality with the strong one. In this case it is submitted that the weak vessel loses her own character and becomes distinctly a torpedo vessel, and advantage should be taken of torpedo tactics pure and simple in delivering the attack. Tubes for this purpose could be placed aboard any vessel on very short notice, and it is thought that the chance of such a condition arising is not sufficiently great to warrant other action than the mere consideration of the circumstances as here set forth. On board the larger vessels, where the room can easily be spared, the retention of a couple of tubes for practice is the adopted policy, and war-heads might be supplied to such ships. If they are, however, it should be understood they are for these forlorn hope tactics, and no captain should be subjected to censure because of their presence should he prefer to go into an ordinary action with them stowed away below.

J. The Use of Boats at Distances from their Bases. When Possible and how best Accomplished.

62. It may sometimes happen that it is highly desirable to operate the boats at a distance from their base, in spite of the fact that only partial results are to be expected from such action. It should be distinctly understood that there is but one way in which anything can be done. That way is to have them accompanied by a repair and depot ship which can carry their weapons and help them to groom themselves at the end of the passage.

63. It is not believed that any successful results could be expected under the circumstances unless the boats could find smooth water at the end of the run for a long enough time to enable them to get in condition and rest the crews prior to the attack.

64. Almost every officer in the navy feels that he appreciates the severity of the service on board torpedo vessels, and all realize the fact that no crew, at the end of a long passage, would be in fit condition, without rest, to do justice to themselves or to their weapons.

65. Here again comes in the question of the adjustment of the gyroscope. Without it the torpedo is a weapon of very

doubtful value, with it badly adjusted it is even worse than without it; with it in proper order the weapon is almost one of precision, and this advantage should not be thrown away; but how are we to tell on board ship whether it is in adjustment or not? There are two ways of telling, one by putting the machine in the adjusting stand on shore, and the other by running the torpedo for an exercise run. The writer knows no others.

K. Modifications of the Theoretically Perfect System made necessary by our Lack of Boats, Officers and Men.

66. In every effort to lay out a consistent scheme of any kind in our service, we are met by the lack of means to carry it out, so that we always have to adapt our plans, which we are of course prone to consider the best, to the material available. So in this case our theoretical scheme (the main features of which the writer hopes to see in operation before his day is over) will have to be changed, probably, along the lines here indicated.

67. The less important coast districts should be included (for purposes of boat handling alone; their identity should never be forgotten, nor the effort to bring them into real being relaxed) in the neighboring districts.

68. The number of boats in a section must be reduced to five, or even three. In this case several sections should be frequently brought together for exercise. They would in time of peace be, more or less, together all the time, under the proposed arrangement.

69. The navy yards will have to be used as bases, but efforts should be made to relieve the flotilla, as far as may be, of the many papers and much routine of the big navy yards.

70. Where men and officers are lacking to keep all the boats going, a large crew should be assigned to each section, and they can go from boat to boat and care for them all, taking them out for exercise in turn. The writer wishes, in this connection to utter a most impassioned protest against the custom of laying these boats up with only the ordinary navy yard care. They cannot stand it, and the ruin of the flotilla will result if it is largely resorted to.

71. Here, as in some other parts of the paper, it does not seem necessary to go into further details. Those will adjust themselves as work progresses.

L. Types of Boats and their Standardization.

72. In regard to the styles of boats most available for general service of the nature indicated, the writer recognizes but three types that can be advantageously employed. They are:

(a) Torpedo-boat destroyers.
(b) Torpedo-boats of the type described below.
(c) Torpedo-boats to be carried by ships.

73. The destroyers are here regarded, for our purposes, as the highest type of torpedo-boat, and their use has already been indicated. The ones we are now building are of a little over 400 tons displacement, a little under 250 feet long, about 24 feet beam, and a mean draft of about 6½ feet, with a speed of about 30 knots. This seems a serviceable type for our purposes.

74. It is thought that the best type of torpedo-boat would be something between the Du Pont and the Morris. The Du Pont is rather long for easy handling, being 165 tons, 175 feet long, 17¾ feet beam, 4¾ feet mean draft, and 28.51 knots speed. The Morris is somewhat smaller than necessary, being 105 tons, 138 feet long, 15½ feet beam, 4 feet mean draft, and 24 knots speed.

75. The writer believes that if a boat larger than the Du Pont is desired, it would be well to use a destroyer, and there is no object apparent in building smaller than the Morris. It is not thought that the Mackenzie would be any less distinguishable at night than the Morris, and the difference of draft is not of sufficient importance, in the writer's estimation, to warrant the loss of seaworthiness consequent upon the adoption of the smaller types.

76. The only argument the writer can find in favor of the Mackenzie, McKee, Talbot, Gwin class is that they can go through the canals. Under our present treaty with Great Britain, in regard to the maintenance of war vessels on the great lakes, this is perhaps an advantage. It is believed that the transportation of the larger boats by rail could easily be contrived in case of necessity, and it would certainly be a most wise thing if experiments in that direction could be carried on. This would at once do away with the one advantage possessed by the smaller boats. It may be said that in the two Herreshoff boats of this type (the Talbot and Gwin), which are beyond

question the best of the four, their advantages in regard to capacity and weight are gained by the use of only a single boiler, which makes the boats so liable to a complete breakdown that they are not fitted for independent action of any sort. In other words the Herreshoff boats have been made unsafe in order to make them light and speedy.

77. The writer does not believe that standardization of types can be carried to the lengths that some authorities expect. It is not thought that the crew of one boat could transfer to even a sister boat and successfully operate her without previous experience with the particular vessel. The familiarity of the men with the particular boat they are to operate is thought to be of more importance than all the standardization possible, when coupled with a familiarity on the part of the officers with the other boats and officers of the section. Standardization is a most excellent thing, and the writer does not wish to be understood as decrying it, but a valve may be built just like another and still the two may be very individual in their action in such mechanisms as we are called upon to deal with in the torpedo business. Torpedoes cannot be so built that familiarity with a type will qualify a man to operate with certainty all the individuals of the type, and the same applies with more or less force to boilers, engines, etc.; and, last but not least, compasses.

78. In regard to speed, the writer doubts the advisability of building for such high speeds in small boats that weights have to be unduly reduced. It is thought that a sure 25 knots available on short notice, with solid, reliable machinery, is better than 30 knots which can possibly be attained but which brings with it a fair chance of breakdown. The length of time in which the extreme speed will be employed is not so very great, and the difference between twenty-five and twenty-eight knots, for that interval, will not amount to much. The Morris type, increased slightly in size, seems to be a good one.

79. The submarine boat is hardly far enough along for serious discussion, but the type certainly offers the perfection of coast-defense torpedo work. The Holland Company seems to have a very good boat, but further trials are awaited with interest.

80. In this connection it may be well to refer to what are known as the "freaks" of the navy. After a careful examination of the Katahdin, the writer believes her to be a most valuable adjunct to the harbor-defense fleet. As a part of a night

attack upon blockading vessels, which must of necessity be at a low headway, a vessel of her type (with more speed if possible) would be a most dangerous factor. Presenting in the approach almost no target, what there is being eighteen-inch armor, and hence impenetrable to secondary battery shell, and with the low chance of a hit from heavy guns at night, it is firmly believed that an attack would stand every chance of success. Certainly with several of that type in New York harbor, together with say twenty torpedo-boats, all in the hands of determined officers and men who are thoroughly familiar with their weapons, the chances of occasionally striking one of an enemy's fleet in the neighborhood would be most excellent, and the presence of such a flotilla would be a most powerful deterrent upon hostile action, to say nothing of the drag it would be upon the hostile personnel.

81. The Vesuvius has yet to prove her usefulness, but it would be of interest to try a torpedo-boat with one of these guns on board so arranged that great range is not sought; in other words, to take the weapon out of the gun class and regard it as a torpedo of superior range and accuracy.

M. Types of Torpedoes.

82. Prior to the adoption of the Obry gear, the writer was a believer in the Howell torpedo, because it undoubtedly ran through to the point for which it was aimed, something which no other torpedo could be depended upon to do. Now, however, the gyroscopic steering gear gives to the compressed air torpedo practically all the advantages of the Howell, while retaining its own particular good points.

83. The Whitehead and the Schwartzkopff are the two best known and most successful automobile torpedoes; and, without discussing the relative merits of the two, it may be said that a torpedo can now be made use of in service which shall carry about 130 pounds of explosive at a speed of 30 knots for 800 yards with extreme accuracy under all conditions of firing (provided the weapon is in proper order) with an initial air-flask pressure of 1500 pounds per square inch, and which will run accurately for 1000 yards at a speed of 28 knots. The difficulty of keeping the gyroscope in adjustment has been touched upon elsewhere. With it, the torpedo can be launched, from a fixed

submerged tube for example, and then be made to change its course after firing and take up any desired direction within reasonable limits. These statements are of what has already been done and not of possibilities. It will be seen, therefore, that the torpedo, within the limits claimed for it in this paper, has made great strides towards becoming a weapon of precision, and is no longer a thing which the enemy can afford to disregard.

N. The Bearing upon the above Statements of the Lessons of the Spanish War.

84. It is believed that the arguments herein advanced are all borne out by the occurrences of the late war with Spain.

85. The Spanish torpedo-boat flotilla went to the Cape Verde Islands, and there the scheme of bringing the smaller boats across had to be abandoned. The idea was wild from the beginning. The three destroyers came over with the fleet and were from the start a drawback and not an advantage, and when they arrived one of them had to be left in Martinique broken down. The other two were in doubtful condition. Whenever they appeared before our ships in the day-time they were quickly put out of action, and they never did come out at night. So they really accomplished nothing. The conditions at Santiago were exceptional, in that our fleet was allowed to keep the only exit, a very narrow one, brightly lighted at night. That the inertia of the forts allowed these conditions to prevail and the destroyers were therefore unable to even attempt anything is no just argument that under proper conditions they could not have done their work. No fleet could keep a proper flotilla from coming out of New York harbor for instance, and the presence of such a force within would certainly have the very greatest effect upon the conduct of the blockade. The writer is firmly convinced that the successful torpedoing of a large ship under these circumstances would be no infrequent occurrence.

86. From our own point of view in the war, the fact that the torpedo-boats cannot be used as cruisers and despatch-boats and blockaders and still retain their efficiency was amply proven. The fact that a few of the boats were carried through the war without breakdown owing to the superhuman efforts of their personnel and other causes does not lessen the force of the argument. In the same way the fact that the boats did not go into

the narrow harbor of an enemy, facing certain destruction from the heavy boom that was certainly to be found across the entrance, is no proof that they could not have come out of their own harbor. In point of fact, by the time the thing could have been attempted, our flotilla was so broken down by other uses that it would have been very hard to have gotten together a sufficient number of boats to make the effort.

O. GENERAL SUMMING UP.

87. To sum up, it may be said that under the circumstances here pointed out as favorable for torpedo warfare, with the modern types of the weapon, the writer is confident that success is more than likely to follow a daring effort by experienced men. To have men and implements always at the highest point of efficiency should be our great aim, and this cannot be done except by keeping the vessels in commission and their personnel at work.

88. As has been said before, there seems now to be no definite scheme or policy laid out, and it is hoped that criticism of the points here set forth may develop something towards which we can look as an ideal and which we can struggle to attain.

89. And here it may be of interest to give some historical facts as to the use of the automobile torpedo. Full accounts of the actions may be found in "Ironclads in Action," by H. W. Wilson, and there it will be seen that the results here given have been generally attained under disadvantageous circumstances. Of course the weapons employed were in no case fitted with the gyroscopic steering gear.

90. May 29, 1877, the English Shah fired one Whitehead torpedo at the Peruvian Huascar, but it had not power enough to run the distance.

91. December 27, 1877, the Russian Tchesme fired a Whitehead torpedo at the Turkish Mahmoodieh, and the weapon ran straight but exploded before reaching the target. The Russian Sinope fired another at the same time, but it failed to explode.

92. January 25 1878, the Russian Tchesme and Sinope fired one Whitehead torpedo each at the Turkish guard ship at the entrance to the harbor of Batoum, both of which exploded under and sank the Turkish vessel.

93. January 27, 1891, a torpedo launch from the Chilian

Blanco, in revolt, fired a Whitehead at the Balmacedist armed steamer Imperial, but missed her.

94. April 23, 1891, the Chilian government vessels Lynch and Condell attacked the revolutionary fleet in Caldera Bay and fired five Whitehead torpedoes, one of which sank the Blanco Encalada.

95. May 14, 1891, the Condell and the Lynch again attempted to surprise the revolutionary ships, but could not get near enough to fire.

96. April 4, 1894, the Brazilian government vessels Gustavo Sampaio, Alfonso Pedro, Pedro Ivo and Silvado attempted an attack on the revolutionary flag-ship Aquidaban, but were repulsed before they got within torpedo range. The next night they tried again, and one of the four torpedoes fired sunk their adversary.

97. July 25, 1895, the Japanese claim that in time of peace the Chinese Tsi Yuen treacherously fired a torpedo at the Naniwa, but missed her. The Chinese deny, and probably truthfully, that this ever occurred.

98. September 17, 1894, at the battle of the Yalu, the Chinese fired several torpedoes, but all missed.

99. January 30, 1895, sixteen Japanese boats attacked the Chinese fleet in Wei-hai-wei, but failed.

100. February 4, 1895, at the same place, the same attempt was repeated, and again failed.

101. February 5, 1895, the attempt was again made, and as a result the Ting Yuen, Wei Yuen and Lai Yuen were sunk at once, and the Ching Yuen was so disabled that she sank not long after.

102. It is seen here, leaving out the doubtful case in which the Japanese claim a breach of peace by the Tsi Yuen, and followed it up by a savage attack on her, that out of eleven attacks, four succeeded, resulting in the destruction of seven vessels. And this was with weapons far inferior to those of to-day and under adverse circumstances, as a rule. The moral is that there are immense possibilities in the torpedo, and we cannot afford to neglect them. We must have a policy and must follow it, and the sooner the service awakes to a fuller appreciation of the chances offered by this weapon the better we shall be prepared with a warm reception for any hostile visitors to our coast.

DISCUSSION.

Captain C. F. Goodrich, U. S. N.—The prize essay of this year impresses me as a peculiarly logical endeavor to solve an important professional question. Personally I cannot pretend to sufficient familiarity with the details of the subject to pronounce judgment on the answer found, but as the steps in the argument are based on the solid ground of experience I am content to accept the result.

It is only by careful study of tactical needs that a satisfactory building programme can be evolved. We are too ready to adopt new types of vessels simply because of their appearance in foreign navies or because of some ephemeral wave of public opinion at home. Had we approached the larger matter of ships in the thoughtful manner of the essayist we should not have now to regret the expenditure of vast sums in certain constructions for which no place exists in the fleet. I think the essayist's method deserving of the highest praise and I cannot refrain from expressing the hope that the same method may even yet be applied to the working out of ship types. We should build nothing whose functions and employment are not demonstrated in advance by careful study of our necessities, and the lessons of the past—nothing of which the position in the fighting line or among the auxiliaries is open to any shadow of doubt. Thus only shall we have a homogeneous navy; thus only can we cease to produce an assemblage of craft to which the unhappy term of "job lot" is applicable.

Captain C. F. Goodrich, U. S. N.—I have read Lieutenant Chandler's essay with much interest and great profit. If I venture to criticise, I hope I may be understood as attacking the one point wherein I think the writer has fallen a victim to the allurements of an ever present siren. Were he to cast his eyes about him he would find himself in extremely good company—I had almost said the very best, for among those who share his views are certain officers of great distinction and exceptional mental capacity.

I will only touch upon his Section (C). To be brief and to the point I must say, with perhaps brutal frankness, that I differ with the writer *toto coelo.* The underlying idea of this section violates, in my judgment, every historically sound maxim of naval strategy. The motto *divide et impera* is to be applied, not by ourselves to our own resources, but by an enemy who would gladly see us do exactly what the essayist proposes.

The mere fact that we should require one hundred and seventy-five boats with say an average of three officers each, or five hundred and twenty-five line officers, more than one-half of all the commissioned officers we now have on the active list, shows how impossible of realization is such a scheme as this, even if it were desirable. We can only succeed in war when the fleet in all its branches is controlled by one man. When hostilities break out, our Commander-in-Chief's first move would be to concentrate his forces and not to dissipate them in the manner set forth in this essay.

To localize our defenses is a favorite plan with many, but feeling so strongly on the subject as I do, an earnest protest on my part is in order and seems to be imperative.

"TORPEDO CRAFT: TYPES AND EMPLOYMENT."

Captain ASA WALKER, U. S. N.—The masterly manner in which this subject has been treated by the essayist, and his logical deductions from the accumulated data have served to make up a paper of great interest and value to the service. The main and vital features set forth cannot fail to receive the assent of all interested in the subject.

The question as to the displacement of the Destroyer, may possibly not as yet have reached to the point of solution, but there can be no doubt as to the fate of the smaller torpedo-boats.

I look upon the suggestion of replacing the one-pounders by six-pounders as most sensible, and its adoption would be a step in the right direction.

I fear that the so-called sea-keeping powers of the 165-ton torpedo-boat will prove delusions, and that their use will be confined to home waters or cruising in summer seas. Even there life on board will be hard enough for their crews.

I am glad to see so much stress laid upon what are oftentimes considered minor details, comfort and convenience for the personnel. These, to my mind, are quite as essential, especially in protracted operations, as speed and power of offense. However perfect may be the weapon of warfare, it is, after all, upon the brain directing it, that the effect depends. So intimate is the relation between body and mind that the weariness of the one leaves its trace on the other. To be sure that the brain is acting up to par, it should be seen that the body be not worn and weary. To this end every possible convenience should be given to crew and officers.

Unfamiliar as I am with the internal arrangements of the boats, I doubt not that the suggestions of the essayist are all valuable and to the point, yet perhaps some other torpedo man would desire other devices. How would it do to convene a board consisting of four line officers, who had had experience on the boats, one of whom, as an engineer, and one naval constructor. The duty of this board to be confined solely to internal arrangements for comfort to crew, and convenience of stowage for equipments and supplies. The approved report of such a board would standardize the living quarters, if carried into effect.

I fully agree with the essayist on the importance of keeping the torpedo fleet on a service footing, at all times, and of requiring regular and constant drills. It might be practicable to make partial changes in crews, at stated intervals, so that the boats would become schools to the general service, to a limited extent. This should not be carried to the extent of hazarding the efficiency of the torpedo fleet.

The thanks of the service are due to the author for so clearly stating its needs as well as pointing the way toward their realization.

"THE AUTOMOBILE TORPEDO AND ITS USES."

Captain **ASA WALKER**.—The logical and earnest manner in which the essayist has treated his subject, demands of the thinking minds in the service, the highest appreciation. Any attempt at criticism from me would indeed be to "rush in where angels fear to tread." The organization proposed seems most excellent and greatly to be desired. The appointment of a chief of the flotilla, with specified duties pertaining thereto, would seem to be the first natural step to a systematization of the service. The division of the coast into districts, with the detail of torpedo sections to the respective areas presents features of the most pronounced utility.

The essayist's plea for full crews for the boats, *at all times*, will meet with the unqualified assent of all service men, who have given the subject a thought. His arguments with regard to the personnel are well founded and convincing. It is self evident that however good may be the boat and the torpedo, if "the man behind the gun" be untrained the result of action will be disaster.

There would seem to be little prospect that the torpedo-boat or the destroyer will be called upon to act across the ocean, but both should be prepared for service in our West Indian possessions and dependencies, for there will probably be the field for our future naval conflicts.

I am of the opinion that the essayist takes a pessimistic view of the danger attending the delivery of a torpedo-boat attack when he says: "No one can go out expecting to return." This view is not upheld by the summary of such attacks given. Not all members of the forlorn hope are killed. While a torpedo attack may be looked upon as the most desperate of naval encounters, yet even in defeat, it cannot mean death to all engaged—though looking death in the face, he who thus engages should feel that in success lies his greatest chance of escape, and fix his whole mind on the achievement of that success.

As the essayist says an organization of some kind is imperatively needed, whose details can be worked out later, meanwhile the service should thank any one, who pushes this need to the front.

I feel that my personal thanks are due to the essayist for the pleasure and profit found in his admirable paper.

Commander F. J. **DRAKE**, U. S. N.—Lieutenant Jackson has treated the subject of torpedo craft, types and employment in a very clear, concise and practical manner.

Following carefully the results which have been obtained by England, France and Italy in experiments and the development of torpedo-boats as a factor connected with fleet manœuvres, they have not as yet produced any definite results, with regard to the size of the different classes of torpedo craft, which practically will combine an offensive and defensive line of attack in connection with a fleet.

It is to be observed that every time any fleet manœuvres take place the torpedo-boats as a rule invariably break down, if kept at sea for a few days only; thus defeating the carrying out of their part of the programme as a factor in the unit of offense or defense.

I thoroughly agree with Mr. Jackson that during the late Spanish-American war our torpedo-boats performed every duty, except the one for which constructed, and that duty not with complete success, owing to the frail structure of the boats, their want of sea-going qualities, cramped quarters, lightness of machinery; to say nothing of the hardships endured by the officers and crew, their skill and seamanship displayed in keeping afloat, while so gallantly performing their part of the trying ordeal. The impossible has been attempted with torpedo-boats by ~~all nationalities~~, with the result that the object sought has not been accomplished ~~beyond a~~ doubt, either in practice trials at sea or in action. In my opinion, the failures ~~being due to~~ the limited displacement for the so-called sea-going class, high speed required ~~(which by the~~ way is never maintained with satisfaction under cruising conditions calling for ~~emer~~gency action) consequently light structural strength of hull and engines.

I concur with Mr. Jackson in a division in three classes for torpedo-boats, but the destroyer class should be capable of keeping the sea for ten or fifteen days under a cruising speed of twenty knots, if necessary. The sea-going class of torpedo-boats to be limited to a radius of action of one hundred miles from their port, and then only under conditions of weather in which they are fully equipped for immediate attack, and not with everything stowed below for safety and stability while outside. Station boats to be used entirely for harbor and inland water defense. These to vary in tonnage up to 200 tons, as circumstances require.

The destroyer class to range in tonnage from 1000 to 2000 tons; to have a cruising speed of twenty-five knots; maximum about twenty-eight knots; to be able to maintain their cruising speed as long as their coal supply lasts; to have a protective deck, with living quarters above; in construction to be composed of plates and frames of not less than ten pounds; no water-tight doors in bulkheads; compartments below protective deck to be accessible through water-tight shutters in the protective deck; the shutters to be surrounded by cylindrical water-tight trunks, the latter fitted with water-tight doors and constructed on the protective deck, independent of the upper deck and frames; the shutters to be mechanically operated from the compartments which they close; twin screws; engines to be of the quadruple expansion type; water-tube boilers with all modern improvements; buoyancy and floatability not to depend upon that portion of hull above the protective deck; to carry two torpedo tubes in light spheroid revolving turrets on bow and quarter lines with above-water discharge; armament to consist of a limited number of six- and twelve-pounders; draught not to exceed twelve feet; the living quarters and out-of-the-water part of the hull to be built on to the protective deck; the latter extending the whole length of the vessel.

Destroyers of this type would be able to go to sea; carry their crew and officers comfortably; live out all kinds of weather; be self-supporting, sea-going boats suitable for our long line of coast where harbors are far apart. These vessels will be able to overhaul similar torpedo-boats of the so-called sea-going type, although the latter may have a higher maximum speed (determined over the measured mile), which can be maintained for a very short time only. When pushed by a destroyer of this class capable of cruising steadily at a twenty-five knot gait, the so-called torpedo-boats will very soon break down, and thus be overhauled and destroyed.

It must be considered that so-called torpedo-boats of high speed, cruising at sea for a few days, lose a certain amount of their efficiency by virtue of the wear and tear on the engines and crew. Should they, under these circumstances, fall in with destroyers of the type mentioned, having sea-endurance limited only by their supply of coal, the torpedo-boats under the most favorable conditions of weather, in my opinion, would become an easy prey in a very short chase; hence I advocate destroyers of this type.

Taking the battleship as a unit, two destroyers will become its consort. For our coast defense and possessions in the West Indies, as well as future protection of the approaches to the Nicaragua Canal, we would have a defensive fleet protection of the battleship type without a parallel.

Sea-going torpedo-boat type. The sea-going torpedo-boat described by Mr. Jackson under Class " P " then fulfills all of the requirements for an off-shore harbor defense in connection with the fleet. I should, however, build these boats with heavier frames and plates, increasing their displacement to between three and six hundred tons, with a twenty-knot cruising speed and a maximum of twenty-five knots for six hours at least. The armament and other conditions described are excellent. Clear decks are essential with the exception of hatches, conning towers and launching tubes. Gangways around hatches, however, could have a light hand-rail, stanchions of iron, with rope rail rove through the eyes of the stanchions.

In deck coverings I should advocate gratings, half wood and half papier-maché. This would be better, lighter and more durable than wholly made of wood.

Concerning Charts. The Hydrographic Office should get out a set of Coast Pilot charts for torpedo-boats made in squares of about eighteen inches. These should be pasted on stiff backs with a compass on each section of chart; the sections numbered in rotation, which are necessary to make up the present whole chart by an addition to the present number of the chart, put on the back of each section: For instance, "A-1," "A-2," "A-3," etc. For example, "Chart of the Straits of Florida, including Florida Bay" could be divided into four sections; each section would be marked on the back with catalogue number, No. 15-A-1, No. 15-A-2, No. 15-A-3, No. 15-A-4. The backs of such charts, being shellacked, will be protected from the weather and prevent warping. They can be easily stowed and handled under these circumstances, when placed alongside each other in the order of sequence, fulfill all the requirements of the larger chart, and this under all conditions of weather, especially in cramped quarters.

With regard to air compressors: in order to overcome the great difficulty which was experienced with our torpedo-boats during the late war, in the bulging of the sides of the cooling tanks of the air compressors, due to excessive pressures, the introduction of a pressure regulator and relief valve attachment to the compressor circulating pump, as proposed in the Fox and Davis will be found beneficial, where suction is through one outlet, both for the circulating and compressor pumps.

Lieutenant Jackson's remarks with regard to the torpedo director are not only logical, but practically correct. It would be well to go further and say that torpedo directors are of use only to a torpedo officer in a battleship or armored cruiser carrying torpedoes, who is directly and solely giving his attention to the range and bearing of the enemy from his point of lookout. In conning towers of vessels of all description, they are not only a nuisance, but a hindrance to the proper functions of the conning tower, because of the impossibility of any commanding officer or other person who is engaged in conning the ship in a fight to give his attention to any other duty. If he does so, the space passed over by both ships in the meantime so changes their relative positions that he loses sight of the vantage point of the best fighting position for himself with reference to the enemy. The functions of conning towers in all vessels should be given to steering wheels, engine- and steering-room connections, indicators and communications, and no other. These are all one head, in the present age, can clearly and intelligently manipulate at one and the same time, where seconds involve relative changes of positions of combatants of such magnitude that the result will be disastrous to one or the other in a few minutes of an engagement. These are conditions in which when closing with an enemy the battle becomes decisive, of short duration and much relief to the victors.

Steering Engines. These should be of the same type in all boats under the destroyer class. They should be compact, light, and should occupy a limited space of not more than fourteen inches square. Engines of this type have been fitted in the Fox, Davis and Goldsborough. They are light, handy and have perfect control.

Guns on torpedo-boats and destroyers should be mounted so as to have an all-around fire, exclusive of smokestacks, ventilators and masts. They should never be compelled to change the course of the boat running at high speed and lose distance, in order to bring the battery into action. When approaching to launch a torpedo, the crews should never be at the guns. The latter should be manned only in case of defense for protection from the destroyer class, or for bringing-to similar boats or clearing the approach to the beach for a landing party, when not opposed by masked or other shore batteries. The question of an attack upon a superior depends upon the probability or chance for a swimming match. In the daytime torpedo-boats will have a greater moral effect in the presence of or near an enemy by keeping out of sight.

Their original design and construction was and is only intended for night attack and then under the most favorable circumstances of weather and total darkness. Never less than two boats should attempt to attack a superior vessel. The attack should then be from opposite bows or quarters and should be simultaneous. This condition will be the most harassing to the object attacked, while insuring the greatest safety to the torpedo-boats. The unit of action in all manœuvres should never be less than two boats and these should always function together. One is a stimulus to the other, and two cool heads are better than one in outlining any action of this character. All tactics for torpedo-boats should be developed on this base. They should always exercise, cruise, scout, plan and fight together.

Under such circumstances and from observations which I have made of manœuvres of vessels of this class, this appears to be the only clear solution for reasonable success in action.

Torpedo-boats should never be convoys to a battleship, except when the latter is at anchor or underway within their sphere of action; that is, in harbor or within a radius of twenty-five mile limit to the entrance of the same. Battleships cruising, should each be accompanied by two destroyers, as outlined, of 1000 to 2000 tons displacement. Then will the commander of the battleship be the better able to control the immediate action of his own vessel in all conditions of weather, and not be borne down with anxiety for the safety of his consorts. He will then feel safe and strong, not only in the conviction, but in the fact, that they can live and fight with him in any weather in which he may desire to make an attack.

The details of equipment, officers, distribution of boats, drills, etc., have been very clearly outlined by Mr. Jackson, and further comment thereon can only be brought out by practical applications of his suggestions and results obtained.

"THE TORPEDO-BOAT, DESTROYERS, AND DEPOT." P. 851, No. 92.

R. C. SMITH.—I am warmly in accord with Lieutenant Koester as to the desirability of the early establishment of a torpedo-boat depot. The subject was very fully discussed by Lieutenant Ellicott three years ago in the Institute Proceedings (p. 441, No. 83). He there enumerated seven requirements in locating such a station, and I can think of no other to add to them—and found that they would all be satisfied near Peconic Bay, Long Island. It is certainly an ideal location, as every one who knows it cannot fail to realize. Navy yards are the last place for such a depot. As a rule there is not room and the boats are in the way. Then there is no one specially interested in them, since the principal work is in connection with larger vessels. Such work as is required to keep a boat in ordinary repairs does not necessitate a very extensive plant. The machine shop needed for work on the torpedoes would also answer for most of the work required on the boats.

The expedient of hauling boats out for storage is open to argument. Abroad, it has been found that it strains the boats and gets the machinery out of line. It is possible that a fresh-water basin and small floating drydocks for lifting the boats when it became necessary, to sight the bottoms might be preferable.

I am not convinced of the impossibility of the crews of boats in regular commission living on board with a fair degree of comfort. In my own experience it was possible under peace conditions; under war conditions it would be necessary. Men and officers are not apt to take the proper interest in a boat unless it is also their home. This for boats in commission: for those in reserve, a necessity perhaps that we may have to admit, though I agree with Lieutenant Koester it would be better to keep them all in commission, a single crew could man four or five boats and keep them all efficient. This crew could of course live in barracks.

I think I am also in accord with him as to two types being sufficient, leaving out, of course, vedettes. I wish the requirements of inland navigation did not limit the size of destroyers so absolutely. About 300 tons is as large a boat as can use these passages. (Does not refer to the Erie Canal.) Our largest boats cannot go through the canals. To be sure a destroyer is expected to accompany the fleet, and it may never be necessary for one of them to make an inland passage; but the capability of so doing, if necessity did arise, could not be an undesirable quality.

It is a pity, however, that there is not some other necessity which would make it impossible to increase the size of our destroyers any further. I think the requirement of invisibility should do it, but that does not stop the designers and builders. The gradual increase in size of destroyers, abroad as well as at home, threatens to duplicate the experience of the English with the now discredited torpedo-gunboats.

"PRIZE ESSAY, TORPEDO CRAFT: TYPES AND EMPLOYMENT."
P. 1, No. 93.

R. C. SMITH.—Lieutenant Jackson's essay is the fruit of three or four years' actual experience with several types of torpedo-boats. It offers exactly the sort of information most needed in designing new boats and perfecting old ones. After a new ship or boat has been a year or two in commission, her officers and crew know pretty well what there is about her effective and serviceable and what is impracticable or a failure. If this knowledge could be card-catalogued and made absolutely available for future designs, there would be a steady improvement in equipment and fittings of all kinds. There is no doubt a great deal of such information on file available in large ship designs; for torpedo-boats probably much less. Therefore every paper of the character of this essay is a positive addition to knowledge.

I agree very generally with the views expressed and consequently will refer to only a few points in regard to which there is still room for argument. I should add in regard to air-compressors that in view of the frequent failure of these machines, two small ones might be better than one large one. Cases could be imagined in which two air-compressors might be almost as essential as two engines.

The classification of boats by the letters O, P, Q, R, is intelligible and offers a good basis for discussion. The essayist finds places for all the types except Q, the boat of 100 to 150 tons. I have advocated hitherto O, Q, and the smaller vedette type of R, hence we are substantially in accord except as to P and Q.

Now the argument for P as opposed to Q is derived in the main from the Spanish war experience. P performed all that was required, Q was found deficient. Could not this result be due to the fact, admitted by the essayist, that the principal work required was despatch-boat duty and not torpedo-boat duty? P certainly has greater sea-keeping qualities than Q. The only objection I make to her is her larger size, and hence greater visibility. As her chief mission is the torpedo attack pure and simple, it seems to me that invisibility is an imperative desideratum.

Now as to operating in the West Indies: I hope we shall always have there several stations and bases. We certainly shall in Puerto Rico; perhaps we may in what are now the Danish West Indies; and even after Cuba becomes independent she will no doubt always grant us stations. Hence if class Q will answer for temporary service with the fleet on our own coast, it probably will also in the West Indies. In bad weather it will be able to seek shelter in either locality. Class O, however, the destroyers, will be the principal type for independent sea-keeping, not only with the fleet, but often for detached work, if we can manage to build enough of them.

In the next war the temptation will be to use these craft for despatch-boat duty just as we did in the last, and in fact there will be no help for it, unless in the meantime we build special despatch boats. I had thought to see several of them authorized at the last session of Congress, as the war had shown a crying need for them. A boat of 1000 tons, on the lines of the destroyer, and with the same speed, no torpedoes, a very light battery of semi-automatic guns, sufficient to protect her from destroyers but no more, then all the rest of the available weight and space given up to boilers, machinery and coal (preferably liquid fuel); such in brief are, to my mind, the requirements for a despatch boat, and we ought to have a number of them as early as possible.

As to the ordnance outfit of the torpedo craft, I believe the correct principle is more and smaller guns, within limits. A one-pounder is practically of little use. A three-pounder will penetrate to all parts of a destroyer or torpedo-boat. I believe then that more three-pounders and more ammunition are preferable to the same weight in six-pounders and their ammunition. The question is not complicated here by armor. The objective is the personnel and the boilers and machinery. The more shots there are, the more chances of effective results; and for that reason three-pounders appeal to me more than six-pounders. I believe also that one or two guns of the Colt pattern would be found useful against the enemy's personnel.

I have already written something about laying up the boats in a discussion of Lieutenant Koester's paper. If it has to be done, I should prefer a fresh-water basin. Rather than that, however, I should turn them over in large numbers to the naval militia organizations. What matter if some boats are injured? The militia will have to be depended on to man most of the smaller ones in time of war, and to do this it is of course necessary for them to have practice in time of peace.

There is evident a tendency to call a halt in torpedo-boat construction. The only apparent reason for this is an impression that has gone abroad as a result of the Spanish war. Torpedoes seem to be discredited. Our boats accomplished nothing, the Spanish boats accomplished nothing.

The only chance for our boats would have been Santiago; but in view of the character of the entrance it would have been almost certain suicide for a boat to have gone in. The attempt was not warranted, considered either before or after the event. As to the Spanish boats, or destroyers; they made no night attacks and were quite easily disabled or destroyed by daylight. Their real mission, indeed, was not to attack ships, but to defend their own ships from the attack of our torpedo-boats. Notwithstanding, if those destroyers had had American crews under similar circumstances, they would have found a way out of Santiago harbor by night. They might have perished, but that is all they accomplished anyway. There is no other evidence than this. Yet through the country at large, and even through the service, there is a very comfortable feeling, that there is not so much in that torpedo-boat nightmare after all.

There may be another reason for not building torpedo-boats at present, that we have no officers or men to man them. Would it not be possible to authorize a minimum number of officers and men for the service, bearing a certain relation to the number of vessels at present available, then whenever a new vessel was authorized add to all the grades and rates enough officers and men to man her? For instance, it is easy to determine what our present strength should be. We have only to assign suitable complements to the vessels on the Navy list and those authorized, with a fixed proportion for reliefs and shore duty. Now a new vessel is authorized; could not the same act authorize the addition of a suitable personnel in the proportion established, less the numbers already available by reason of vessels crossed from the list? The present Navy bill is said to provide for two battleships, three armored cruisers, three protected cruisers and four gunboats. The complements for these vessels, considering only line officers and men, with twenty-five per cent additional for shore duty and reliefs, are estimated at 10 captains, 35 lieutenant-commanders, 135 lieutenants and ensigns, and 5750 enlisted men. Could not these additions to the personnel be authorized at the same time? There are probably some objections, but it is doubtful if any of them are insuperable. Notice that all additions to the various grades are made in the exact proportion of the numbers needed for duty. As to filling vacancies at the foot, if the proposed four years' course at the Naval Academy, with the additional presidential and senatorial appointments, does not supply enough candidates, then an appointment could be made from each Congressional district every three years, and eventually every two years, keeping the course at the Naval Academy four years or any number of years that might seem advantageous.

"THE AUTOMOBILE TORPEDO AND ITS USES." P. 47, No. 93.

R. C. SMITH.—It was a fortunate thing that the two principal contestants for the Institute prize this year should have selected subjects so nearly akin. Their papers, both the result of personal experience, round out a subject that is timely and important. To the men who have been at all interested in torpedo work, the value of the arm seems greater now than ever. For some reason, as I have mentioned in a discussion of Lieutenant Jackson's essay, an opinion seems to have spread abroad, even in the service itself, detrimental to a continuous steady development of this form of warfare. These two papers will do much to dispel this illusion.

Lieutenant Chandler's views on the individualism of torpedoes and especially torpedo-boats are peculiarly apt. Any man who has had experience with more than one boat is profoundly impressed with these facts. Standardization in groups is valuable for two reasons, first for facility in repairs and the supply of spare parts, second for similarity in manœuvring powers for group action. That any amount of standardization will ever enable a crew to shift from one boat to another and be entirely familiar with her on the first trip is clearly impossible to those who have had experience. It is not realized by others and it is very well brought out by Lieutenant Chandler.

I also am a little skeptical as to the possibilities of the German wedge formation for attack in any except perfectly calm weather. No doubt, however, it can be opened out a little under other circumstances. If the enemy's location is absolutely fixed and known, concerted attacks can be made without a group formation. If the enemy has to be sought out, the group is necessary; and it will be well for us to practice the German method or devise one of our own.

This is now what we need more than anything else, practice with all the boats that are available. If we have not enough officers and crews, cannot Congress in its present generous mood to the Navy be induced to remedy the defect? There are three problems that ought to be worked out at the earliest moment. One is the group formation for cruising in search of the enemy, as already mentioned. Another is the method of getting through the enemy's picket line. The only way to determine this is to devote a week or two when the squadron is at Newport this coming summer to an exercise at a thorough defense by pickets, vedettes, and destroyers; and an attack by torpedo-boats and destroyers. It may be explained briefly that I understand by pickets the pulling boats of the squadron and by vedettes its 50- to 60-foot fast launches, of which we have none, though there seems no question that they should be carried by battleships and large cruisers. Pickets and vedettes can be used ordinarily only when the squadron is at anchor, destroyers at all times. The third problem is the possibility of disabling the boats by gunfire after they are discovered. A practicable way to accomplish this might be to have a destroyer tow a light target resembling a torpedo-boat at the end of a long steel wire. The destroyer would steam at high speed and pass directly ahead or astern of the vessel attacked. At a given signal the search-lights would pick up the target and the secondary battery would open up, firing for a given number of seconds. This idea, as far as I know, originated with Captain Evans. It promises valuable lessons.

I hardly believe that second-class boats aboard ship or torpedo-depot ships will be useful in the future. The question is too long to discuss here, but I went into it rather fully in a paper published in No. 81 of the

Proceedings. A general repair-ship, like the Vulcan in the late war, will prove of the greatest use to each squadron. In place of the second-class torpedo-boats aboard ship I believe the vedette launches already mentioned would be far more valuable.

I believe also that the destroyers will have to accompany our fleet wherever it goes. On a hostile shore would be just the place where they would be most necessary. It is true the Spaniards did not accomplish much with their destroyers, but they brought them over. We should hope to do better. In this connection, why is it that we have so many successful experiments with liquid fuel, and then do not hear anything more of it? The best way to introduce liquid fuel for torpedo-boats and destroyers is probably just to introduce it. If there are any defects in the methods and appliances they will soon be remedied. Think what this would mean for destroyers on a long cruise with the squadron. When they were out of fuel they would take a line and a hose from one of the big ships, and coaling would be over in ten minutes. The saving in size of engineer's force could go to more comfort, more stores and more ammunition.

I do not believe we ought to talk about modifying what we consider the best method of employing our torpedo-boat flotilla on the assumption that we shall be unable to get boats, men and officers that are shown to be necessary. Congress is favorably disposed, the press is favorable, and the people are favorable. All that is needed now is to show it to the proper authorities in the proper light.

In conclusion, I may say that I have pointed out some few details in which I do not agree entirely with Lieutenant Chandler, but with most of his ideas I am heartily in accord, and I believe that every paper of this degree of merit is bound to accomplish some result.

Lieutenant-Commander F. F. **Fletcher**.—There is little to criticise in this article (The Automobile and its Uses), which presents an interesting statement of the opinions upon torpedo-boat questions, and reflects the popular conception upon many of the points involved.

In much of the literature upon torpedo-boats there exists a number of ideas that are accepted without question, but which may need revision, when viewed in the light of historical data, or a more detailed analysis of the results obtained in this mode of warfare.

One of these prevailing ideas, dwelt upon by most writers, is the extreme peril attending the attacking torpedo-boat.

This is emphasized in the essay by the expression of the opinion that those who engage in a torpedo-boat attack should not expect to return, or if such an idea is seriously entertained they should remain at home. This is a very gallant and commendable spirit, but I would like to bring some facts to bear upon this point, which may afford a more encouraging view to the young officer ambitious to make a torpedo-boat attack and yet desiring to live and enjoy the honor of success.

In the battles of this last century, we find that trained troops will withstand a certain percentage of loss before demoralization sets in, and defeat becomes probable. The loss varies from about forty per cent, as at the battle of the Wilderness and at Leipsic, to seven and a quarter per cent at Modder River. A lost of twenty or twenty-five per cent is considered quite severe and is a satisfactory explanation of defeat. This percentage of loss refers to troops in the field, but it is a principle governing the conduct of personnel in action, that applies, except under special conditions, to any other mode of warfare.

We will now examine the results of torpedo-boat attacks and ascertain what bearing they have upon the dangers and risks involved.

Torpedo-boat warfare was inaugurated over thirty-five years ago. At that time the attack consisted of a comparatively slow-moving boat of from four to seven knots speed, which had to come in actual contact with the vessel to deliver her blow. The vessels as a rule had a broadside battery of eight or ten guns in addition to machine guns and small-arm fire. Then came the development of the offense by an increase of speed in the attacking boat to twelve or fifteen knots in addition to a towing torpedo to avoid coming in actual contact with the ship. This was shortly followed by the introduction of the automobile torpedo and greater increase of speed, until finally we have the high-speed boat and longer range torpedo, with the addition of a rapid-fire battery.

On the other hand, the development of the defense has made equal strides in advance. In this gradual development of the offense and defense it will be interesting to see how far the balance of power has been distributed since the first attack against the "Ironsides" on the outside blockade of Charleston.

During the days of the spar torpedo there were fifteen attacks by torpedo-boats, three of which took place in broad daylight and twelve at night. In one of these day attacks two ships were sunk while the two attacking boats and crews received but little injury. In another daylight attack a single boat got alongside of an ironclad and escaped without injury. The third daylight attack of two boats against a monitor was unsuccessful though neither boat was sunk.

Of the twelve night attacks, one was abandoned when the ship opened fire.

Of the eleven night attacks where the boats rushed in, eight of them succeeded in getting a torpedo alongside, two exploded against a boom and one failed.

Of the eight attacks in which the torpedo was placed alongside the ship, one failed to explode, three exploded and injured three ships, and four exploded sinking four ships.

There were thirty-three torpedo-boats employed in these fifteen attacks and the number of men employed was about three hundred and fifty.

Three boats or nine per cent were lost.

Twelve men or about three per cent were killed.

These losses were caused principally by dangers incident to the attack, but the *gun-fire of the ship* did not sink a single boat and killed only one man. On the other hand six ships were sunk, three were injured and over five hundred lives lost.

In all these attacks we cannot fail to be impressed by the amount of gun-fire the boats withstood, without being disabled or the crews demoralized, and this from ships, whose broadside fire amounted to nine or ten shots a minute in addition to small arms and machine guns.

The accounts tell of the boats being greeted with a "general fire of artillery and rifles" and a "hail of bullets," a "storm of projectiles," a "fusillade of musketry" poured down upon them.

We will now examine the results under more modern conditions presenting a marvelous change in the character of the weapons employed, in both offense and defense.

There have been nine attacks with the automobile torpedo, three of which took place in broad daylight. In one of these day attacks the boat was well within torpedo range under the rapid-fire battery of a ship in action and escaped injury.

In the six night attacks in which the boats ventured within torpedo range, eight vessels were sunk, comprising three armored cruisers, three cruisers, a tug-boat and a schooner.

In only one night attack out of the six did the torpedo fail to sink a ship, and as might be expected, this was the first attack ever made with an automobile.

In these six night attacks twenty-seven boats were employed, though only sixteen discharged their torpedoes and were under fire. One boat was disabled by gun-fire and one was lost by running aground.

About five hundred men took part in these attacks, and the loss of personnel was less than two per cent in killed, and of boats about twelve per cent.

The histories of the spar torpedo and the automobile torpedo, show them to be much alike in their operations. Each weapon has a record covering a period of about twenty years, during which time each was employed in four different wars in which seven different nations were engaged. There is the same percentage of success and failure, the same percentage of loss in material and personnel. With each weapon, about thirty boats have been employed in attack, in which about six per cent were lost in both cases, with about three per cent of the personnel. The spar torpedo sunk six ships and the automobile eight.

The figures representing the percentage of losses given above are more than a mere coincidence. They are the results of the natural balance of power that exists under normal conditions of attack between the offense and defense irrespective of weapons but regulated by that general principle of danger and risk which governs the conduct of the personnel in the battle.

Theoretical calculations, as to the chances of a torpedo-boat under a rapid-fire battery of to-day are not at all convincing, but such a calculation based upon the probable number of hits required to disable a boat, the size of the target, the time under fire, and the known percentage of hits usually made in battle would indicate results approximating very closely to the experience of the past, and that the modern boat holds the same relation to the rapid-fire battery of to-day, that the slow-moving launch of a generation ago held to the gun-fire of the ship of that date, and that a modern attack if well chosen even in broad daylight is not of necessity a forlorn hope.

There is one other point of the essay I would like to touch upon in reference to types of boats and to the last appropriation for sixteen destroyers of a type larger than any built abroad. A study of the gradual development of this mode of warfare suggests the idea that it has developed beyond the smooth-water protected harbor stage and passed on to the open sea. In the former case the accessories to aid the battery form a specific defense, but on the open sea the defense is not yet developed. Extending the curve of development a little beyond its present limits I am inclined to agree with the opinion that for our coast no more boats of the smaller type need ever be built.

Commander W. W. KIMBALL, U. S. N.—In offering a few comments on the prize essay of the year, I would state that it seems to me that I can in no way add to the interest in the discussion upon it by accentuating the great value of the paper, since the jury of the Institute has accentuated it in the most satisfactory manner.

I will, therefore, confine my remarks to those matters in regard to which my point of view is more or less different from that of the essayist.

The application of the motto "Experientia docet" does not seem clear, because in our service we have not had enough experience to learn much about torpedo-boats, because we entirely neglect the slight experience we have had, and because as shown by the essayist at the bottom of p. 44 we don't like to be taught by experience any how. We prefer to receive vivid impressions from the pronouncement of dicta and dogmas, and in regard to torpedo-boats, we follow our preferences because they are so much more comfortable than are the teachings of experience. Possibly I am wrong in this, but upon no other theory have I been able to account for the curious facts that never has a torpedo-boat attack drill been attempted in the U. S. Navy, and that the few search-light drills taken part in by ships and torpedo-boats have been so singularly arranged.

In regard to types, I differ slightly from the essayist in that I cannot give the sea-keeping boats enough importance for the rôle assigned them to provide them with a well-grounded reason of being: for the work laid out for them by the essayist could be better done, it seems to me, by a smaller number of destroyers, provided in excess of those required for the constant defense of the fleet.

So of station boats (5): more dependence for real work could be placed upon a smaller number of sea-going craft—station boats (a). Therefore I would have but two types of torpedo craft, sea-going boats of 120 to 150 tons displacement and destroyers of 400 to 450 tons, for the requirements defined by the existing conditions of our coasts and of our fleet. Reduction in numbers of types would seem to lead toward standardization of details in which we are so sadly lacking, and without which torpedo craft must, of necessity, be comparatively inefficient.

I cannot agree with the essayist that a couple of 50-ton boats would give a certain feeling of protection to the people on the whole coast of Massachusetts Bay and thus liberate more valuable and powerful vessels for offensive operations; for those people have been aided by the generally expressed opinion of the Navy in concluding that all torpedo craft are useless, and therefore, it would be most difficult to humbug them into depending upon a couple of very apparently inefficient ones. Judging from the effect of the public panic on that coast during the late pseudo-war, those people would demand for their protection in a real war, at least, a real torpedo-boat protection, and failing that, the fleet.

We of the Navy must remember that in all our future wars the movements of fleets will not be directed by commanders-in-chief toward determined objectives, but by public opinion for local coast protection unless a real coast protection be worked out, organized and so perfected, as to make it efficient—not merely a tub to throw to the whale of public opinion: for our whale cannot be readily fooled; and if it could the Navy itself would explain that the thing was only a tub after all; because of all things delightful to us, we of the Navy delight most in exploiting our own weaknesses—in proving that we are irritatingly honest and honestly stupid in all that pertains to the slightest comprehension of the force and power of public opinion. A real coast protection must be provided and must be publicly understood to be worthy of its rôle. That the mobile part of this protection—the coast defense ships and torpedo-boats—is the most important part, every sailor man must clearly see, no matter what our brethren of the shore service may say of the importance of shore works and mines. If we cannot provide such a torpedo-boat protection, then our battleships will surely be relegated to torpedo-boat duty in the next war; and no plaint of ours to the effect that battleships were intended for something else, will be of the slightest avail. Our sword may be a very fine sword but under the direction of our sovereign, the public, we will have to use it as a buckler if there be no sufficient buckler at hand, and have to refrain from testing it at all, as a striking weapon.

And so I do not agree with the essayist's suggestion as to the larger boats being designed to act with a squadron. Abroad they have grown out of that idea, and for us, it would to my mind lead to inefficiency to allow our boats to act with the squadron in any way save and except the acting against it in real torpedo-boat attack drills. Acting with the squadron in our service would surely mean running errands, carrying wash-clothes and anything but preparing for that serious defense of the coast upon which the liberation of the fleet for its own legitimate work entirely depends.

Let the destroyers act with the squadron: they are designed for such work; they can stand more abuse before becoming completely crippled, and besides they are part and parcel of the striking force which is to be freed from strictly coast defense work by the torpedo-boats, if freed at all.

It would be idle for me to take the time of the meeting in exploiting my personal notions as to the best method of obtaining the best investment per dollar expended in a real torpedo-boat service—in going into the questions of numbers, distribution, care, drills, scheme of work and all that—for the department's files are lumbered with such stuff; and moreover the time has not arrived for the consideration of such matters. Let us first consider what torpedo-boats are for, let us give the matter as much attention as civilians very generally do, let us decide whether or not they can fill any rôle other than the only one we now assign them, i. e., the giving of trouble and expense in providing some means for storing them away on shore, and the rest will be easy. For without boasting, I think our record of work done in the Navy is sufficient ground for supposing we would utilize torpedo-boat material very creditably if we made up our minds that we wanted to utilize it at all: and that we could even get a great deal of service out of the heterogeneous lot of boats on hand.

Whether our attempts in the way of organization, etc., were the poorest possible or the best is not now important: for any attempt in any direction must be infinitely better than our present attitude, for the same reason that unity is infinitely greater than zero.

The essayist's criticisms of details of construction and equipment are very interesting to people interested in torpedo-boats and their work. But that they can have no interest for the service at large is shown by the facts that practically all these suggestions upon practically the same details were filed in the department eighteen months ago, were issued to constructors in charge of building torpedo craft, were published in a nautical paper a year ago—*Marine Review*, March 2, 1899—as matters of interest for civilians, and were proved by the logic of events to possess no interest at all for the service. I would, however, venture to accentuate the necessity of one detail, probably overlooked by the essayist for the reason that he was considering an aggregation of single boats and only touched lightly on the matter of groups, that of proper towing appliances.

The arguments of the essayist as to battery seem to me to be entirely logical, if in his scheme of weights, the stiffening of the structure to take six-pounders has been carefully worked out.

Personally I would prefer to substitute one very low power fourteen-pounder for one of the six-pounders in torpedo-boats in order to give the boat a better chance to stop a destroyer, when the boat was at her legitimate night work. Under such conditions the extreme range at which the target could be made out would be 800 yards and for that range a poor trajectory could be put up with for the sake of the large shell power.

It is well to remember, too, that the aid to good shooting due to flat trajectory is proportionately much less in a torpedo-boat doing her twenty-five or more rolls a minute than in a ship designed to give a good gun platform.

In designing such a gun I would go at once to the most economical velocity—the velocity at which the projectile barely begins to feel the drag due to base vacuum or replacement waves—about 1000 feet I. V. And I think that it would be found that the gun would be within limits of toleration as regards weight and to be possessed of comparatively better shooting qualities under the given limiting conditions, than the high-power daylight shooting we do would lead us to imagine.

Commander W. W. Kimball, U. S. N.—It is very refreshing to read a paper on torpedo craft policy for the United States that covers the ground so completely and so logically as does Mr. Chandler's essay. It is very delightful to find a U. S. Naval officer with courage and optimism enough to advocate openly and without shame 175 real torpedo-boats for real torpedo-boat work; when most of us believe that the 35 of all kinds of queer ones we now have are more than we need; and that these 35 should be used, chiefly, to provide the approximate dimensions for the fine large store sheds to be built around them. And so it becomes difficult to disagree with him on small details—which I must do in order to find an excuse for discussing his well-held points, at all.

The seven-boat section he advocates is without doubt the proper group unit and one that appeals to any one who has handled grouped boats. Personally I do not like the idea of a destroyer for a section leader, because it has been borne in upon me by experience that the section commander should always have the aid of his judgment in requiring work from the boats, that is given him by being in a craft exactly like those he is handling.

We have all observed the fact that the point of view as regards sea and weather from the fine large flagship leading the van with an easy agreeable motion is quite different from the estimate of weather conditions made on board the rear gunboat jumping into it up to her smokestacks; and in torpedo-boat work where exactness of manœuvring counts for so much, it would be well, it seems to me, to eliminate all grounds for such differences of opinion.

The German wedge is an entirely practicable formation even where, from the designs and dimensions of the boats, the German distances cannot be held. I do not like the idea of barracks for crews at torpedo-boat bases because the change from comfort ashore to discomfort aboard would be too marked and because there is a practical benefit in keeping the men afloat even when tied up to a dock. The idea of the expenditure for the bases frightens me while it dazzles me with its attractiveness. And so my mind reverts to the floating base, not a Vulcan as advised in Par. 55, but the small depot and section supply ship suggested to the Board on Auxiliaries a year ago last October and recommended by the board. Such a depot ship would allow great mobility in concentrating sections and in moving them anywhere along our coast from Eastport to Galveston, or San Juan Point if necessary; and anywhere within a hundred miles of the anchorage of the depot ship the section could keep itself tuned up and ready for work in all respects, save docking. The depot ship would supply the machine plant, the sick-bay, the spare parts, the reserve pumps, the clothing, etc., beside the fuel, oil and waste supplies.

Depot ships would be much more economical than the fine shore bases advocated, and while much less satisfactory in certain directions, would be better for many tactical reasons, and for a tremendous practical reason in the eyes of torpedo-boat men—she could carry two or three hard working clerks aboard her, who could make out the absolutely necessary reports and returns and requisitions.

Being a submarine-boat crank of fifteen long discouraging years' standing, I of course, cannot agree that the submarine boat is hardly far enough along for serious discussion. Most assuredly it was most seriously discussed abroad a half dozen years ago when the European technical and service publications did me the honor to discuss a paper of mine on the technical value of the type; and there are cheering indications that we, too, will awake to its possibilities, in a half dozen years more. But whether we do or not, the submarine has come to stay: and her capabilities within her narrow field of work are to-day better known from the results of trials than are those of surface torpedo-boats, or for that matter, of battleships, from the results of their trials.

Lieut. E. W. EBERLE, U. S. N.—The efficiency of our torpedo service would be decidedly advanced by the adoption of many of the principles advocated by Lieut. Jackson and Lieut. Chandler in their valuable papers on torpedoes and torpedo craft. A definite "building policy" for torpedo craft should be adopted and strictly followed. I believe we should have three classes of torpedo vessels, as follows:

1. Destroyers of 500 tons displacement and 28 knots speed.
2. Coasting torpedo-boats of 200 tons displacement and 26 knots speed.
3. Harbor defenders of 100 tons displacement and 23 knots speed.

I am opposed to sacrificing strength and sea-worthiness in destroyers for the purpose of obtaining phenomenal speed. In order to gain a few more knots in speed, the frames, plates, and machinery of torpedo vessels are shaved down to the very limit of safety. The vessels are lacking in stiffness, and their excessive vibration at high speed, in moderate weather, soon disables the lightly-built engines. I would much prefer a 28-knot destroyer with strong frames and comparatively thick plates and with good sea-going qualities, to a 32-knot vessel with its light frames and "egg-shell" plates, and consequently with a sea-worthiness so questionable as to make it a source of constant anxiety to the commander-in-chief and to its own commanding officer, even in moderate seas.

The *lightly-built* destroyer with its *phenomenal speed* is out of place in a cruising fleet, while the strongly-built vessel with its good sea-going qualities and its *reliable speed* should be able to cruise with the fleet and take care of itself in all kinds of weather.

I hope to see an early adoption of the principle, "Torpedoes in torpedo vessels and in nothing else"; and I hope to see large, stout, well-armed destroyers, with strongly-built engines and with ample coal and water supply—destroyers capable of *developing and maintaining a sea-speed of 28 knots whenever called upon.* Such vessels would not hamper the movements of the fleet, and instead of being a source of weakness and annoyance, they would prove a most valuable adjunct. On a displacement of 500 tons we should be able to build a staunch and speedy destroyer. To my way of reasoning, it is far preferable to have with the fleet a class of strongly-built destroyers which will respond with a steady speed of 27 or 28 knots whenever called upon, than to have a lightly-built class with a reputed speed of 32 knots under favorable conditions of wind and sea, whose speed is more a matter of record than of fact, and whose toy-like engines are liable to "refuse duty" at most inopportune times.

I will reaffirm here what I advocated several years ago in a discussion on the subject, that in my opinion the appropriation for each battleship or armored cruiser should contain a provision for *two destroyers*. These destroyers should attend the battleship during all manœuvres; and in time of hostilities they should serve as her faithful "watch-dogs" at night, always on the alert for torpedo-boats and rams. The service these destroyers could render a fleet would prove most valuable—some on the scout and others on the lookout; and they would form the inner picket line for the fleet, the outer line being formed by the large cruising scouts. How much more secure and comfortable the fighting ships would feel when on the blockade or when approaching the enemy's coast, if each one had two efficient destroyers to insure protection against night attacks of torpedo craft. The destroyers should be a "part and parcel" of their *parent-ship* and should look to her for everything.

The coasting torpedo-boats should have an *actual speed* of 26 knots, and should be strong enough in structure to be able to accompany the *sea-going* fleet during moderate weather in cruises along the coast and at all times to accompany the *coast-defense* fleet.

The "harbor-defender" class should be lightly built and able to maintain 23 knots for at least one hour; and their duty should be to make night attacks from blockaded harbors. Their cruising should be confined to inland waters, and they should traverse the canals in going from port to port. These small vessels should be attached to the *harbor defense* monitors and rams.

In general, the destroyers belong to the sea-going fleet; the *coasting class* to the coast-defense fleet; and the harbor-defender class to the harbor-defense fleet.

Torpedo vessels of the destroyer and coasting classes should be kept in commission with full crews, but the harbor defenders should be laid up with reduced crews during the winter months.

These vessels would constitute a most excellent training service for officers and men.

No officer above the grade of lieutenant should be assigned to command a torpedo-vessel, and no officer or man should be kept in a torpedo vessel longer than two years. This training on torpedo craft would give to the naval service a set of sharp-witted young officers, self-reliant and quick at meeting emergencies; a class of bright young seamen alert in their duties, who would make good material for future petty-officers; and a well-trained and efficient engineer force with a thorough knowledge of handling and caring for delicate machinery.

Torpedo vessels in the hands of any but the most efficient personnel are next to useless; and an efficient personnel can be obtained only by long, hard experience of torpedo craft. There is no calling in the professional or commercial world which exacts such thorough knowledge, self-reliance, and constant care, as must be exacted of the officers and men of torpedo vessels, if they are to render efficient service. Men who have been trained in torpedo-boats will readily adapt themselves to the various duties on cruisers or battleships, and at the same time they will constitute an intelligent reserve force for manning or filling vacancies in torpedo vessels.

Naval Constructor **William J. Baxter**, U. S. N.—The Institute is to be greatly congratulated upon receiving this paper (Torpedo-Boats: Types and Employment), as it is of that type which adds great value to the Institute's proceedings. It not only shows the results of much laborious study and painstaking compilation of details, but also shows an unusual amount of careful observation during practical service experience, together with well-considered suggestions for improvements which personal experience suggested as desirable or necessary.

It is, of course, well known that a ship will compromise in her design; it may not be so well known that recommendations concerning the improvement of any completed vessel which has seen active service are so numerous and so contradictory that the element of compromise is still exceedingly strong. And while I concur with many of the author's suggestions, and while I consider many others of them of extreme value, it is but proper to state that there are still other of his suggestions which should not be adopted. This is said, not in a critical or disparative sense, but merely as the expression of personal opinion. No doubt, a large majority of the readers of this valuable article have the same opinion as regards their agreement or variance with the author's views, and it is extremely doubtful if any two readers would agree entirely in their opinions. These varying opinions, however, really increase the value and weight of the paper, because the author has stated his own opinions in a clear and positive manner after much thought; whereas those mere verbal commentaries, which are not infrequent in our own and other services, are not entitled to much weight.

The Navy Department's policy, of the new torpedo-boats of different sizes, by different builders, and of different designs, is well shown by this article, because if they had all been built of the same size and upon the same design there would have been no opportunity for this instructive article, and it should be remembered that for similar reasons it is not necessary that any one particular design, no matter how perfect it may appear to be under any one set of conditions, should be repeated indefinitely. This applies not only to the design of the vessel itself, but to every detail of her construction. It has been the common experience of myself, and no doubt that of many others, that even in regard to the most minor details of sister ships, an article which was entirely satisfactory to one officer or one petty officer, is entirely unsatisfactory to others, and it is only by hearing the opinions of a large number of officers and weighing their experience and judgment that final and absolute improvement can be made by those of us who build and fit out the ships.

It has been my endeávor for a number of years to urge and carry out simplicity in all the details of warship construction, and it is a pleasure to see the strong argument for simplicity in torpedo-boat construction brought forward by the author, as it has been my ordinary experience to find that the officers of ships in commission always want something more added, thus increasing the complication, while it is extremely rare to find an officer to speak seriously of having something removed without having something else put in its place.

The author deserves the thanks of the entire Institute for his very valuable paper.

Naval Constructor T. F. Ruhm, U. S. N.—In order to satisfy the desire for great speed in torpedo-boats and torpedo-boat destroyers, the weights of machinery and hull must be reduced to a minimum, thus increasing the possibility of serious accident to both. The extreme lightness of the scantlings of the hull increases the effect of the tendency of all parts to vibrate, and such extreme vibration must undoubtedly affect not only the strength of the material but the nervous systems of those on board. The reducing of the speed requirement by two knots and the increasing of the weights of hull and machinery accordingly would give a really more efficient vessel, less liable to accident, and more capable of standing whatever weather may be encountered, or whatever handling around docks, etc., may be necessary in the course of the general duties of the vessel.

In the case of the trial trip of one of the fast destroyers the vibration of the stern plating was such that a piece of one of the plates in the neighborhood of the propeller by constant buckling finally broke and a three-cornered piece was torn out by the rush of the water, the stern compartment rapidly filling. On the same vessel, in trying to get away from the dock, the stem was gently touched against the adjacent wharf, the result being that the stem was absolutely twisted out of shape and part of it required replacing. Were the scantlings of this boat consistent with the duty required, accidents of this sort would have no serious results.

While the fitting of small ventilators which are always open may be undesirable on account of the possibility of salt water and rain entering through such ventilators, it would seem that arrangements should be provided for ventilation under favorable conditions, provision to be made to readily close such openings when necessary. The fitting of some arrangement of this sort in each principal living space or cabin, so arranged as to be readily closed from beneath, should give satisfactory results. A type of bent cowl with a scuttle at deck opening which can be closed so as to be absolutely water-tight, or partly closed so as to leave a small opening, should be satisfactory, and the location thereof could be so arranged as not to interfere with the gangway on deck.

The fitting of air-ports on the sides of the vessel is very necessary within certain limits, but should not be carried to too great an extent on account of danger due to the extreme height of the bow and stern ways and the squat of the vessel.

The ventilation cowls should be fitted with clamps or screws so that the cowl can be trimmed in whatever direction may be desired, and clamped in place so that it will not turn.

What appears to be a satisfactory manner of lining the living spaces is to fit furring battens against the skin of the ship and on such battens tack asbestos or canvas, well covered with paint.

The having of the closets and bathrooms adjacent to the galley is open to a good deal of criticism, although such arrangement is almost unavoidable. These compartments should be adjacent to the crew's space and each have a door opening into the crew's space, while there should be no means of communication between the galley and closets; the bulkhead separating such spaces to be a double bulkhead with air space between.

An apparently satisfactory arrangement of life rail and stanchions is to omit the low life-rail stanchions formerly fitted, and in lieu thereof provide stanchions at intervals of about twelve to fifteen feet of a height sufficient to take the awning spreaders; and extending between these stanchions five light phosphor-bronze wire ropes, the upper one reaching to about the height of a man's shoulder, and through the tops of the stanchions the awning-ridge rope. These ropes fitted with turnbuckles and so arranged as to allow of proper openings abreast gangways, boats, etc., should give very satisfactory results.

Large drinking-water tanks should as a general thing be made of galvanized iron, and be fitted with manholes large enough to allow access for cleaning. The most natural place for such tanks would be under the galleys. This arrangement I believe is now that generally adopted.

There is in my opinion a very large amount of valuable information contained in this excellent paper.

Naval Constructor T. F. **Ruhm**, U. S. N.—Referring to the paper by Lieutenant Koester on "The Torpedo-Boat, Destroyer, and Depot," there appear on page 853 certain suggestions in connection with which I would submit the following:

The feed-water supply of torpedo-boats can be materially increased by fitting the forward compartment, corresponding to the trimming tank on large vessels, for carrying fresh water, the necessary piping to the feed pumps being fitted. This water can be considered either as part of the main feed-water supply, or as a reserve supply, as circumstances might decide.

The handling of the anchor on a torpedo-boat by the crew without any anchor engine would in my opinion be rather unsatisfactory owing to the arrangement of the turtleback now generally conceded to be most desirable. A small electric winch fitted adjacent to the locker in which the anchor cable is stowed would be comparatively light, would not involve the heating of living spaces by steam pipes, and would occupy space which by virtue of its position in the ship and limited extent, would be easily available for the purpose. Of course such engine would necessitate the existence of a dynamo on board, but this is in my opinion highly desirable.

I question the efficiency of omitting deck covering and supplying the crew with rubber-soled shoes, and think that some deck covering is absolutely necessary, preferably a very light linoleum, the body of the strips to be cemented to the deck, and edges and ends secured by very thin brass strips bolted with light bolts through the deck.

The securing of the deck cover over the boilers with bolts so that it may be easily removed for hoisting out boilers would be a very good scheme if practicable, but I do not believe with such light material the bolting together of these parts could be done so as to give satisfactory results as regards water-tightness and rigidity, especially when attempting to fit the pieces together again after having once taken them apart.

The making alike in every respect of all destroyers and of all torpedo-boats is in my opinion most desirable, and should be carried out even to the smallest details; standard designs should be adopted for water-tight doors, hatch fittings, life rails, eye bolts, etc., and the internal arrangements, locations of batteries, tubes, boats, anchors, etc., should be made identical for all destroyers, and for all torpedo-boats.

Lieut. L. H. **CHANDLER**, U. S. N.—1. In studying Lieut. Jackson's article, I am much pleased to find that in almost all important matters there is a similarity in our opinions. I am very glad to find my views in regard to torpedo matters are in the main upheld by the very able prize essayist of this year.

2. In his "Detailed Criticism and Comparison of Certain Points in Construction," Lieut. Jackson has given many facts which would lead to his being held in grateful recollection by torpedo-boat officers and men, could he succeed in getting his schemes carried out by those who build the boats. A careful study of his remarks on this subject by those who design, build and fit out boats would result in many blessings to personnel.

3. To speak in detail as to one or two points under this head, I may say that the canvas lining of living spaces should be so arranged, open in proper places at top and bottom, that a through circulation from the deck up to the hatches would be ensured, thus sending the heated air up and out instead of confining it between the lining and hull. The deck overhead should have this inside lining also.

4. I believe that the only way to satisfactorily arrange sink and wash-stand drains, etc., is to have them discharge into buckets, to be emptied by hand. The automatic valves on board the Mackenzie were most annoying in their inefficiency, and I do not believe they could be made successful on board any torpedo vessel.

5. As Mr. Jackson says, the officers' quarters should undoubtedly be forward. There are so few officers on board these boats that it is essential that the voice should be able to carry from the officers' quarters to the helm and vice versa. This would mean the greatest relief to the officers when under way.

6. Referring to the steering-gear of the Mackenzie, I may say that (as I understand it also the case on board some other boats) the rudder is so much overbalanced that when the helm is hard over it is much harder to get it started from that position than it was to get it there in the first place. This fault renders her rather hard to handle in tight places, and

an attempt to suddenly steady her when the helm is hard over results in manœuvres calculated to cause astonishment on the part of spectators. This would not have been so important had she been fitted with steam steering-gear, but even then the fault is one which should be avoided.

7. Referring in general terms to a comparison between Mr. Jackson's essay and my own, I believe that the two intermingle very well, that each of us has covered fully some points that the other touched upon but lightly, and that, when taken together, they form a very complete and, in the main, harmonious treatise on torpedo-boat tactics and warfare as adapted to the use of our service.

8. The one essential point on which Mr. Jackson and I differ is as to the classes of vessels we should use. Mr. Jackson favors:

(*a*) Torpedo-boat destroyers. Boats of about 400 tons, and 28 knots speed.

(*b*) Sea-going torpedo-boats (picked). To be able to keep the sea for more than a week. About the size of the Porter.

(*c*) Torpedo-boats (stationary). Talbot class.

Personally I favor:

(*a*) Torpedo-boat destroyers of the type we are now building.

(*b*) Sea-going torpedo-boats between the Porter and Morris types, say about 150 tons, 150 feet in length, 15 feet beam, 4 feet mean draft.

(*c*) Ships' torpedo-boats.

9. It will be seen that we agree as to *a*. Personally I do not believe in the Talbot type, while Mr. Jackson does. This may result from his having been more familiar with the Herreshoff-built boats of the type while my experience was with the others. I believe that the Gwin and Talbot could make 20 knots easily at any time in smooth water, but they have only one boiler apiece, and tubes will give out at odd moments, which means a totally disabled boat with that type. The Mackenzie and McKee cannot make 20 knots in service, in fact the Mackenzie had great difficulty in making it on her trial trip, and the McKee did not succeed. I cannot believe these boats to be efficient, even for harbor work solely, and I do not believe that the difference in draft and visibility between them and my proposed *b* type is sufficient to make up for the superior speed and seaworthiness of the bigger class. So I would have the station boat and the sea-going torpedo-boat combined in one class as given above in *b* of my classification.

10. Mr. Jackson does not touch upon the value of torpedo launches as part of the outfit of large ships, while I believe there is a distinct field for these craft.

11. As to battery, I would arm the types of boat I suggest as follows:

(*a*) Destroyers: Two 5-metre torpedo tubes on the midship fore and aft lines for fire on either side. Two 4-pdr. R. F. guns on the middle fore and aft line, one forward and the other aft. Six 6-pdr. semi-automatic guns, three on each side, one pair with ahead and another with astern fire.

(*b*) Torpedo-boats: Two 5-metre torpedo tubes on the midship fore and aft line for fire on either side. Four 3-pdr. semi-automatic guns, two on each side, one pair with ahead and another with astern fire.

(*c*) Ships' torpedo-boats: One 3.55-metre tube on midship fore and aft line for fire on either side. One 1-pdr. automatic gun.

12. I may say in this connection that spare torpedoes are very good things to have, but nothing else should be given up for them. I agree with Mr. Jackson in this particular, and think that such spare torpedoes should be carried aboard larger ships, either warships or torpedo-depot ships, or retained at the shore base from which the boats are operating.

13. As rapidly as it may be done without undue expense, I would relegate the 3.55-metre torpedo to obscurity, except for ships' boats. I would rather have a boat with two 5-metre torpedoes than one with three 3.55-metre ones. This gives me an additional argument in favor of my type of torpedo-boat. The Morris, which is somewhat smaller than my *b* type, carries three 5-metre torpedo tubes, the Talbot, Gwin, McKee, Mackenzie class are too small to carry more than one long tube and hardly that.

14. Except for the one essential point herein set forth, I have no criticism worthy of note to make upon the prize essay, except to most heartily commend in general the views of my brother officer.

"TORPEDO CRAFT: TYPES AND EMPLOYMENT."

Naval Constructor **LLOYD BANKSON**, U. S. N.—This paper being of such a practical nature, in which the defects and good qualities of torpedo-boats in general are described by an officer whose experience and interest in them render the paper of great value to all those who are interested in the design or ultimate command of these little vessels, I would like to run over briefly a few of the points which interest me particularly as a constructor.

In regard to the number of torpedo-boats it would be advisable to build, I can corroborate the sentiment on page 13, that "these boats would give a certain feeling of protection to the people and liberate more valuable and powerful vessels for offensive operations."

From my experience ashore, in a peaceful community during the late Spanish war, the alarm and consequent efforts to obtain what was considered necessary protection (had the Spanish ships appeared at all off our coast) would have paralyzed the movements of naval vessels, while a single torpedo-boat would, in my opinion, have quieted the unnecessary and unreasoning alarm of the people concerned.

Apparently, from the criticisms and comparisons in this paper in regard to the details of construction of torpedo-boats in this country, the principal item is the question of ventilation.

I do not think that the writer of the paper will find that all those who have had experience with torpedo-boats will agree with him in regard to doing away with fixed ventilators, which is practically what he advocates.

What is taken as a striking example of a ventilator over a cabin, does not seem to be as serious as one might be led to suppose. The fact that this ventilator was probably provided at the bottom, on the inside, with a plate to make it tight in bad weather, shows that the disagreeable features mentioned were anticipated, and, by closing the bottom by the plate provided and putting a canvas hood over the outside, the ventilator was practically done away with and no harm resulted. In hot weather, in smooth water, whether under way or in port, it would seem that this ventilator would have been quite convenient and even necessary.

The suggestion of using hoods over the hatches is a good one, and they have been fitted in the petty officers' quarters on the Dahlgren and T. A. M. Craven. The officers' quarters being ventilated by small screw-down ventilators, a skylight and the after conning tower.

In this connection, I think these small ventilators of the Dahlgren and T. A. M. Craven, while possibly not acting as thoroughly as ventilating hoods, should certainly have no disadvantages in the shape of leaking in bad weather, as they can be hermetically closed.

In reference to the subject of clear decks, I quite agree that they should be as free as possible from obstructions of all kinds, but on torpedo-boats this is a very difficult matter, particularly as even the writer of the paper suggests numerous chests for ice, deck gear, tools, etc., so that at best the decks are bound to be pretty well taken up with different articles, whether they are projecting hatches, ventilators or what not.

In regard to deck covering, it might be better, I think, to go back to the ordinary gratings fitted originally on the Cushing, doing away with linoleum, battens, etc., altogether. The fastening of these gratings with cleats will keep them in place in ordinary weather, and I think, as the writer suggests, they would be valuable in making a raft in case it was necessary to abandon the boat in a hurry.

The writer's suggestions in regard to covering platforms in living spaces have been carried out on the Dahlgren and T. A. M. Craven, and present a very neat appearance, and I trust they will be satisfactory in service.

These two torpedo-boats are ceiled throughout in the living quarters with canvas, both overhead and sides, and it is believed that they will be quite satisfactory, and, if a proper steam-heating arrangement is installed, they should be as comfortable as a torpedo-boat can be made.

The two tiers of bunks, with pipe frame, and loose canvas bottom, I believe are very satisfactory, and I think I can claim credit at least for introducing the laced canvas bottom on the Ericsson. It certainly is light and can be easily kept clean.

On the Dahlgren and T. A. M. Craven the galley is on deck, which is, I believe, a capital arrangement.

I think a fixed bath-tub in a torpedo-boat is rather out of place, on account of the large amount of fresh water required (if fresh water is used) and the valuable space it takes up. The ordinary portable tin tub should be quite satisfactory.

The wooden guard mentioned has been fitted on the Dahlgren and T. A. M. Craven, and is, I believe, an excellent idea.

I have always advocated the cork annular life buoys on torpedo-boats, and believe they should be stopped around the rail, from one end of the boat to the other, on both sides.

A port fire attachment could be very readily fitted to a few of them.

I have always been of the opinion, and still consider (and I believe I am not alone in this regard) that steam steering engines and steam windlasses are unnecessary on a torpedo-boat, although of course they may be of use on destroyers. By having hand steering-gear and hand power for getting up the anchors, the steam pipes in the living quarters forward are done away with altogether, thus obviating one objectionable source of heat.

In regard to the criticisms on ordnance made by the writer of this paper, I do not quite agree with him that our torpedo-boats are under-armed with guns, on account of the strain to the light structure of a torpedo-boat from the recoil of the larger guns, which will ultimately injure the decks to an appreciable extent, in my opinion.

I have dwelt particularly in my statements on the Dahlgren and T. A. M. Craven. These boats represent, I believe, the latest practice in France and contain a great many of the good points required by the author of this paper, and I believe that a disinterested person, capable of judging the good qualities of a torpedo-boat, will find much to admire and but little to criticise in these two boats.

I think there are two slight errors in this paper:

One, on page 8, 4th line; I believe that the 23-knot torpedo-boats referred to had single screws instead of twin screws.

Again, on page 17, 12th line from the top; I think " 30 knots " should read " 29 knots."

"TORPEDO CRAFT: TYPES AND EMPLOYMENT."

Naval Constructor R. M. WATT, U. S. N.—Of all literature on the torpedo-boat and torpedo-boat design, I consider this paper to be the most practical one, and therefore the most valuable. It should be placed in the hands of every torpedo-boat builder and every government inspector, and I believe will assist them greatly when dealing with details of design. On the first eleven torpedo-boats it has been found necessary to remedy many of the defects noted by Lieutenant Jackson.

Relative to types of torpedo craft, I can see no advantage whatever in multiplicity, believing that one type of destroyer and one type of boat will most efficiently answer the requirements of service. The destroyer should be of sufficient speed and armament to destroy a torpedo-boat, or to disable a destroyer, which can be accomplished on about 400 tons displacement. The torpedo-boat should be of the smallest size consistent with *emergency* sea-keeping power, which requirement the Morris appears to satisfy. There is no duty outlined for the sea-keeping torpedo-boat which the destroyer could not more rapidly and more efficiently perform. I can see no justification for the existence of a small, limited capacity station boat of Class R. With a navy suitable to the requirements of the country under the orders of an efficient commander-in-chief, no enemy's fleet is likely to get within the range of operation of the small station boat; and in case an enemy's vessels did force an entry into a harbor, or waterway, the attack should be made by the torpedo-boat proper because of the increased chances of success.

Referring to the detailed criticism, there are points untouched, upon which the views of the sea-going officer, the user of the boat, would be of interest to the designer and builder of the boat.

Does the turtleback type of boat so consistenly followed abroad and adopted on the Cushing, Ericsson, Foote class, etc., make a better sea boat than the flat deck carried to the side, as in the Herreshoff-built boats?

Is the main drain, with which practically all torpedo-boats are fitted, ever used? In practically every case I have investigated, I have found it in an unserviceable condition. Piercing the transverse bulkheads below the water-line, it appears to be a source of danger rather than of value. In case a compartment is flooded, it would be advisable to leave the water alone until the leak was stopped, when the water could be readily handled by a handy billy pump and by the steam siphon with which every compartment is fitted.

I regret that Lieutenant Jackson has not discussed the location of the steering leads, also of the torpedo tubes. Present practice in this country is to carry the steering leads under the deck, which means passing either through a coal bunker or over the boilers, thereby rendering the leads from the forward conning tower inaccessible when the bunker is full, or when steam is on the boilers. Because of their inaccessibility, they are less frequently inspected, and poor condition is very apt to be made known only by a breakdown when repairs are impossible, and a shift to hand-gear in the after conning tower then becomes necessary. I have in mind several instances when a torpedo-boat came into New York Navy Yard with a steering lead carried away, and it was necessary to wait until the next day to permit the boilers to cool off before examination could be made. Further below decks the leads are far more liable to jamming by a splintered or bulged plate. In this connection I call attention to the leads on the Somers, which are placed on the round of the turtleback just outside the line of stanchions, where they are always accessible, and under practically all conditions, emergency repairs can readily be made.

As regards the torpedo tubes: It has in general been considered necessary to place one of the tubes on the center line well aft. This tube will be required for discharge direct astern only when fleeing at the highest speed from a more powerful pursuer. Will not the much-disturbed water astern into which the torpedo is discharged have such a deflective effect upon it as to make its discharge valueless? Would it not be better to locate the tube some distance from the stern when a slight sheer of the helm would permit of discharging the torpedo into water free from the screw disturbance and certainly increase the chances of its reaching its destination?

A word as regards torpedo-boat fittings in general: In torpedo-boat construction, the constant endeavor of the builder has been to economize weight everywhere, in order to secure high speed on the trial trip, until the weight put into certain fittings has been so much economized (reduced) that the fittings have been rendered unserviceable. This question of weight of fittings is not one of vital importance; it is in fact of little importance except as regards builders' trial-trip speed. Should a torpedo attack be contemplated, the vessel would probably be stripped of all fittings: boat davits, torpedo davits, awning and life-line stanchions, life lines, awning spreaders, awnings, deck gear, and all readily removable gear below decks except such as contributed to fighting efficiency. There is therefore no reason why durability and efficiency should not be insisted upon for all of the above fittings, and particularly *demanded* for those upon which the safety of life while cruising at sea depends.

One direction in which this economy in weight has been carried to excess with disastrous results is in the case of life-line stanchions and life lines. When going into action the arrangement of life lines will probably be entirely different from the ordinary cruising arrangement. It has been suggested that one or two stout lines be run fore and aft along the center line of the vessel; perhaps one breast high for fore and aft passage, and one on the deck level with numerous trailers in the water to which it is hoped any one falling would cling.

Profiting by a knowledge of the unsuitable and unsatisfactory fittings which had failed in service, the following general arrangement of life-line fittings has been prepared at New York Navy Yard which are believed to be of the least possible weight consistent with rendering life secure while at sea. Awning stanchions carry the life lines as well as the awning spreaders. Life lines are five in number, the upper life line, forty-eight inches high, taking the place of a life line customarily rigged breast high before taking a torpedo-boat to sea. The lower life line is fitted seven inches from the deck, so as to render it impossible for an unconscious or disabled man to be washed overboard between the lower life line and the deck.

Lack of space prevents further discussion of the many details in which there is much room for decided improvements, which improvements I believe will be materially hastened by this paper.

Naval Constructor H. G. GILLMORE, U. S. N.—Lieutenant Jackson's valuable contribution to the literature on torpedo craft is entitled to especial consideration on account of its writer's association with torpedo-boat work; and the great care and thought which he has bestowed upon the exposition of the opinions which rest upon the experience so gained.

In criticism of his treatment of the matter of types of torpedo vessels it might be said that its discussion is based, in the first instance, upon unsound propositions. To one, who, regarding the torpedo-boat as a weapon, undertakes serious study of the latest types of torpedo craft, and the course of development by which they have been reached, the conclusion is unavoidable that this development has been influenced by many other considerations than those of the torpedo-boat as a weapon. None of the types leading up to the present ones have ever been systematically and carefully tested, after training crews to the peculiar life required by the special service, to determine their fitness for the designed purpose or the lines along which changes should be made. What, then, is there in "practice abroad" upon which we may rest the determination of types for our own use?

The writer's statement relative to the rôles assigned to torpedo vessels during the Spanish-American war are so much to the point that it is surprising that their experience should be advanced as a ground-work for anything, excepting possibly a discussion as to seaworthiness and seakeeping qualities. It is under his third head only that there is introduced a reasonable point from which to begin a discussion upon types of torpedo craft.

The object for which torpedo vessels are constructed is the destruction of vessels of the enemy. It is intended that a vessel costing a few thousands of dollars and manned by a handful of men shall attempt the destruction of vessels costing hundreds of thousands of dollars, carrying hundreds of men. This is the prime object and mission of the torpedo-boat. One division of this special class may be called upon to attack torpedo-boats in order to protect the vessels of the fleet from injury by them.

The condition of equalization which comes in to give the immeasurably weaker unit a chance of success against the cruising ship is the secrecy of action possible under cover of darkness or fog. It is because this equalizing condition makes it possible that, at the risk of a few lives and the product of a few months of toil, the destruction of a vessel requiring many months to construct, costing hundreds of thousands of dollars and involving hundreds of lives, may be effected, that nations are willing to expend the money for, and individuals will risk their lives in attacks in, the torpedo craft. For the secrecy of action and immunity from discovery upon which success is contingent, the torpedo-boat depends upon the visible surface which she presents—that is, upon her size. It is her small size which enables her to creep upon her antagonist and deal the deciding blow. Early discovery means failure to her always, and probable destruction. The protection of the torpedo vessel lies primarily in her size. In her secondary rôle of protector of the fleet against torpedo-boat attack, she is also dependent upon her size for success. To destroy, she must discover, and to discover the torpedo-boats making a stealthy approach it is necessary that the size and visible surface of the guarding boat should not be so greatly superior to that of the attacking boats that they may make her out in time to avoid her. The modern torpedo-boat destroyer, by its large size and attendant visibility, will, under the circumstances which are admitted as possible for torpedo-boat attack, defeat its own purpose. For success in any rôle within its province, it is imperative that the torpedo-boat should be of the smallest size consistent with the other necessary conditions. The advantages in number of men involved in each action, in first cost, and in handiness which accompany small size are so obvious that they need be only mentioned.

This brings up the question of classification. The writer, taking a small section of a general classification of all vessels of war employed in the English Naval Pocket Manual; in which the letters of the alphabet are employed consecutively; substitutes displacement for length and discovers that chance has made possible the use of the words "picked" and "questionable" where they were never contemplated in the original classification. The system of classification proposed is, even when applied only for purposes of comparison of torpedo craft, already built, an extremely loose and inaccurate one. Its use to designate types which it is proposed to fix upon or introduce is indefensible. There is probably nothing about foreign torpedo vessels, of which so little is accurately known as their displacement.

The purposes for which torpedo craft are required naturally divide them into two classes—the sea-going and the harbor or coast defense or, as they are designated in this paper, the station. The so-called torpedo-boat destroyer is only the last term in a series of progressions dictated by many considerations quite foreign to the real purpose of the vessels; but not the less a sea-going torpedo-boat for all that.

This natural division must be recognized; and then a logical consideration of the question, having in view all the requirements in both classes, and giving the fullest weight to all available experience as to seaworthiness and sea-keeping and offensive qualities, would, it is believed, lead to, for the sea-going torpedo vessel, a considerably smaller craft than the present, so-called, destroyers; and for what the writer designates as a "Station Boat," something similar to the small boats proposed by him.

Ventilators. The writer's experience would seem to be directly opposed to that of officers of the British service; for all torpedo-vessels, building for the Admiralty, are fitted with a great number of portable small ventilators, the tendency having been in the direction of increase rather than decrease in number. Sugg's patent ventilators are used; for the compartments under the turtleback, forward and elsewhere, cowl tops of the usual type standing about four feet above the deck. His proposition seems to be to fit hatches with a form of cowl or other ventilating top and omit all other ventilators, so necessitating at least two large openings in even the smaller compartments. It is believed that this would lead to a very much more cut-up deck space and less satisfactory results as to dryness and ventilation in really bad weather.

Clear Decks. The suggestions with reference to this important matter would be most welcome to the builders were they not nullified by the suggestions as to access to and ventilation of compartments, as will be recognized at once should the latter be applied to, say the Morris.

Deck Covering. The effect of the splintering of deck gratings in action should be considered in fixing upon a material for deck covering. If current practice abroad may be taken to represent the teaching of experience, linoleum seems to have stood the test of time.

There can be little question as to the desirability of canvas or other ceiling in quarters of boats upon which the crew are required to live.

Officers' Quarters. The great difficulty in satisfactorily arranging these lies in the great diversity of opinion among those who have to occupy them. When the architect has turned out a type of dwelling, the plans for which every family, with let us say an income of $1000 a year, would accept without suggesting modifications, perhaps naval architects may hope to be equally successful in their efforts to arrange quarters so that every officer who comes to occupy them in the course of the life of the ship will be fully satisfied with them.

The writer's comments upon " Deck Fittings and Equipment," especially as to the utility of metal boats and the failure of folding boats, are deserving of notice.

Whatever the type of steering engine employed, the only reasonable position for it on board a torpedo vessel is the engine-room, where it may have the same care and attention as the auxiliaries of the propelling engines, and its continued use does not result in the heating of living spaces.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVY'S COOPERATION IN THE ZAPOTE RIVER CAMPAIGN.

By LIEUTENANT EDWARD W. EBERLE, U. S. Navy.

June 1, 1899, found the Southern Division of the Insurgent Army in complete control of Cavite Province, with the exception of the small peninsula on which the Cavite Naval Station and the town of San Roque are situated. The northern boundary of the Province of Cavite is marked by the treacherous Zapote River.

Insurgent outposts were located several miles beyond this river, and a considerable force occupied the villages of Las Piñas and Parañaque.

Parañaque—the place where our troops first landed the year before for the attack on Manila—is a small fishing village on the south bank of a narrow inlet of Manila Bay, frequently called Parañaque River, and is only five miles from Malate, which forms the southern section of the city of Manila. Here the Insurgents built strong entrenchments, as they could not approach nearer to Manila without encountering the First Division of our army, which occupied trenches on the opposite side of the Parañaque River.

The U. S. S. Monadnock lay at anchor among the fish-weirs off Parañaque, within easy range of the Insurgent trenches and the bridge spanning the river. She had held this position for two long months—and they were, indeed, long, weary months of constant watching; because being within Mauser range of the shore, she was exchanging shots with the enemy almost daily, while at night her search-lights and patrol boats were detecting *cascoes* and *bancas* in their attempts to run the blockade with all kinds of supplies. Upon one occasion a casco load of horses was captured—evidently prospective mounts for "Insurgent generals."

Few people have fully appreciated the trying work of the Monadnock as she lay there supporting the right flank of our entrenched soldiers and stopping all traffic with the enemy. Being under fire at all hours of the day and night, it was necessary for her officers and men to remain behind the protection of her turrets or below decks; and, as she was cleared for action, the heat was almost unendurable. But, when the commander-in-chief offered to relieve the Monadnock from this arduous duty, her captain, Henry E. Nichols, begged permission to hold his station. He did not live to see Parañaque occupied, as on June 10, after his ship had shelled the Insurgents out of the town and our troops could be seen coming over the hills, he died suddenly of heat-stroke, thus giving up his life for the country he had so faithfully and honorably served.

The Monterey, like the Monadnock, was kept busy day and night. She was anchored in Bacoor Bay and had the Naval Station under her protection, while her launches patrolled the beach to enforce the blockade.

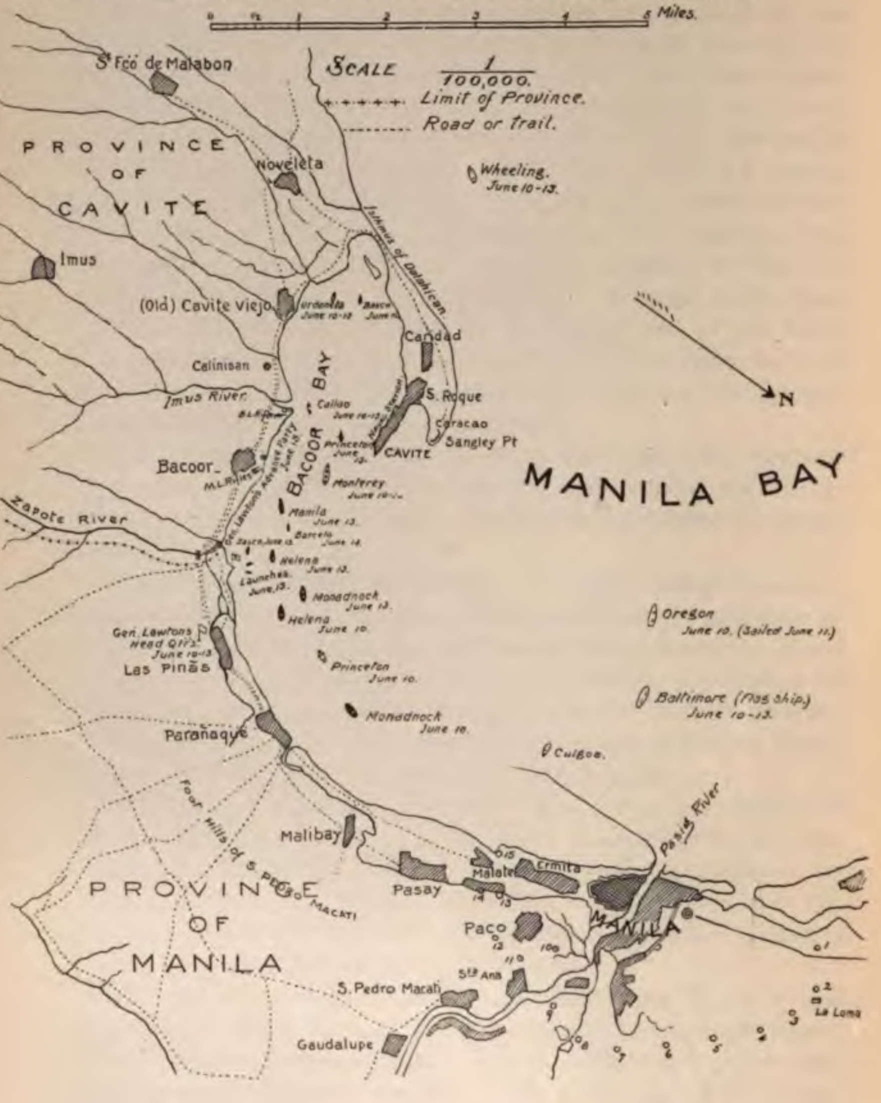
The gunboats Manila and Callao—formerly Spanish vessels—cruised during daylight; and at night anchored in positions to control the narrow Isthmus of Dalahican, which joins the Naval Station to the mainland, and which was held by a battalion of our troops. The Insurgents occupied trenches a short distance beyond the isthmus or neck, and held the towns of Cavite, Viejo, Bacoor, and Noveleta, opposite the Naval Station.

The town of Imus, on the Imus River, was the capital of Cavite Province, and was also the military headquarters of Gen. Baldamero Aguinaldo—brother of Don Emilio Aguinaldo—who at this time was in command of all the Insurgent forces in the province, and with whom Gen. Mariana Trias, a prominent Insurgent leader, was supposed to be associated.

The country between Parañaque and the Imus River is low and marshy, being cut up by many streams and small rivers. The undergrowth is very dense, and the only clearings are rice marshes and mangrove swamps. The main road leads along the shore-line of the bay, and at places is only a few yards from the water. The nature of the country compelled the travel to

PLAN OF CAVITE AND MANILA PROVINCES

COVERING OPERATIONS FROM JUNE 10-13, 1899.



be by this road, and as the bridges were near the mouths of the rivers and the road near the beach, the light-draft gunboats could render valuable assistance by clearing the way for an advancing army and harassing the retreating enemy.

For some time it had been the earnest desire of the commander-in-chief of our naval forces to see the country between Parañaque and Cavite cleared of the Insurgents; but the major-general commanding in the Philippines did not feel that he could spare enough men from the northern wing of the army to undertake a campaign in Cavite Province. To the officers and men of the fleet, it did not appear encouraging to see the Monadnock engaging the enemy almost every day, just outside of Manila, and no move made to occupy Parañaque by our land forces. However, all things come to those who wait. On June 9, the commander-in-chief, Captain Albert S. Barker, U. S. N., signaled for all commanding officers to repair on board the flagship, and the welcome news was soon made known that General Lawton was to move on Parañaque and then into Cavite Province with the cooperation of the fleet. This was, indeed, most gratifying news to every one in the fleet from the commander-in-chief down to the youngest apprentice-boy.

Owing to shallow water, the heavy ships could not approach within effective range of the Insurgent trenches, and therefore the Oregon, Capt. G. F. F. Wilde, and the Baltimore, Capt. J. M. Forsyth, were prevented from joining the navy's inshore firing-line. [See chart.] The Monadnock, Capt. H. E. Nichols, was to shell Parañaque and cover the advance of our troops. The Princeton, Comdr. C. H. West, was to take position between Parañaque and Las Piñas and use shrapnel on the retreating enemy. The Helena, Comdr. W. T. Swinburne, was to control the bridge at the mouth of the Zapote River and the road to Bacoor. The Monterey, Comdr. E. H. C. Leutze, was to look after Bacoor and its approaches, and protect the Naval Station. The Callao, Lieut. Benj. Tappan, was to take position at the mouth of the Imus River and control the bridge and approaches. The Wheeling, Comdr. W. T. Burwell, was to take station outside the Isthmus of Dalahican and enfilade the enemy's trenches, while the small gunboats Basco, Naval Cadet Dungan, and Urdaneta, Navel Cadet W. C. Wood, were to assist from the shallow waters inside the peninsula. The commander-in-chief gave explicit directions to use the utmost care when firing at retreating Insurgents in order to avoid firing upon women or children.

General Lawton's plan was to start the expedition during the night of June 9. He and General Wheaton were to move in two columns. One column was to proceed up the Pasig River in cascoes to the vicinity of Guadalupe, then strike to the southward along the lake and come in below Parañaque to cut off the enemy's retreat.

The ships of the squadron were ordered to be underway and in position in the early morning of Saturday, June 10, 1899. The Monadnock was to open the engagement by shelling the trenches at Parañaque, and the other ships were to use their shrapnel whenever the Insurgents could be seen, and also clear the beach in advance of our troops. Vessels drawing less than twelve feet could approach within one thousand yards of the beach. The vessels were underway and in position at an early hour, and the Monadnock opened fire on Parañaque. It was soon evident that the Insurgents were retreating by the main road near the beach, as the ships opened fire all along the line. The Wheeling opened on the trenches beyond the isthmus or neck. For a time the firing was very spirited, after which it was at long intervals, when several shots would be fired in quick succession at small squads of Insurgents as they dashed across bridges and open spaces. The Insurgents returned the fire of our ships with volleys from their Mausers. About ten o'clock the volleys of our troops could be heard beyond the foot-hills back of Parañaque, and near noon, from the Monadnock's fighting-top, the advanced firing-line could be seen in the hills. There were few signs of life in Parañaque at the hour of noon, but the Monadnock continued to throw in occasional shell. About this time, the writer went on board the Monadnock, and in a conversation with him, Captain Nichols said (referring to the Insurgents in Parañaque): "We've got them now!" These were probably his last words, as later on he was found in his cabin prostrated from heat, and died without regaining consciousness. For some reason our troops did not enter Parañaque but swung around to the southward, and before nightfall had occupied Las Piñas, where General Lawton established headquarters, and signaled that he would remain there over night.

Reports indicated that many of the enemy had been killed by the shrapnel fire of our ships, when crossing bridges and open spaces, but in some instances they were shrewd enough to distribute retreating soldiers among the fleeing women and children, trusting that our ships would not endanger the lives of the helpless and non-combatants. Their strategy was very successful, because our ships ceased firing as soon as women and children were discovered in the retreating groups.

The Wheeling had enfiladed the enemy's trenches located beyond the isthmus, and no signs of life were visible up to nightfall. General Lawton decided to rest over Sunday in order to bring forward supplies, and to enable his men to recuperate from the severe heat prostration they had suffered in the previous day's long, forced march, for the day had been as hot as one of those boiling days in May—Manila's hottest month.

Sunday morning saw the commander-in-chief and a party of officers at Sangley Point standing around the newly-made grave of Captain Nichols—the navy's deplorable loss in the preceding day's work—and the oppressive calm of that tropical morning would not have been broken, save for the funeral volleys and last taps that mournfully resounded over placid Bacoor Bay.

The ships had anchored in positions for controlling the shore between Las Piñas and the Imus River, and were given a comparatively quiet day. The Manila arrived from a ten days' cruise on Sunday, and was assigned a position on the inner firing-line. The Oregon sailed for the north on the same day to establish a blockade of Lingayen Gulf.

The army did not move on Monday, and the ships held their positions, with the exception of the Helena, which vessel took General Lawton and General Wheaton on a reconnoissance along the beach. The two generals and Capt. Sewall, U. S. V., climbed into the fighting-top, and then the Helena, with decks cleared for action and all guns manned, slowly ploughed her way through the soft mud within eight hundred yards of the shore-line. With good binoculars and long glasses, we carefully examined the country from Las Piñas to the Imus River, and located the trenches, roads and bridges, and also two muzzle-loading rifles of about six-inch caliber, which were mounted behind well-constructed earthworks near the corner of the church in Bacoor. These guns were trained on the Naval Station, but their arcs of train appeared very limited. A breech-loading six-inch rifle had also been stolen from the Cavite Arsenal after the evacuation by the Spanish, but a careful examination of the beach failed to locate it, although this was the gun which, according to the rumors of the Amigos, had been promising for weeks to destroy the Naval Station. Many Filipino soldiers were seen in trenches along the shore, and sentries were posted at prominent points. Upon the approach of the Helena, these men sought cover behind earthworks or nipa huts; but not a shot was fired, and we did not disturb them, as we were merely studying the country. We saw in the trenches a number of men belonging to the far-famed "red-legged regiment"—Aguinaldo's body-guard—a Filipino regiment that had been in the service of Spain. After a conversation with General Lawton, the commander-in-chief told the captain of the Helena to fire a shell occasionally into the Insurgent trenches during Monday night in order "to keep the Insurgents awake and their nerves on a tension." During this reconnoissance, a steam launch came alongside with a Spanish lieutenant and three Spanish non-commissioned officers who had escaped from the Insurgents' prison at San Francisco de Malabon and surrendered to the Wheeling. The Spanish lieutenant was taken up into the fighting-top, where in General Lawton's presence he was questioned about the country and the location of the Insurgent forces. He pointed out fortifications along the shore, but said the Zapote River was the Insurgents' stronghold and that they had sworn to make a stubborn fight to prevent our troops crossing that river into Cavite Province. He stated, further, that the entrenchments along the Zapote River were very formidable, being on both sides of the river, and were defended by machine guns and the crack regiments of the Filipino army. The swamps, rice-fields, and dense under-brush increased the strength of the enemy's position and made the two bridges across the river very secure. He said that Aguinaldo's brother and General Mariana Trias were in command and had between four and five thousand men in the province; they also had some six-inch rifles, but he did not know their location, although he had heard that they were mounted in positions to bear on the Naval Station. The military headquarters of the province and the plant for manufacturing powder were being moved from Imus to San Francisco de Malabon.

After this reconnoissance, the writer took the Spanish prisoners to the headquarters of General Otis in Manila. The general had already received, through scouts and Filipino spies, information that corroborated, in a general way, the Spanish lieutenant's statement about the Zapote River. General Otis said the enemy held a very strong position on the Zapote River and they had "sworn by everything holy'" to prevent our forces crossing. It was in the Zapote River swamps that the Insurgents in 1896 had ambushed and slaughtered a large force of Spanish troops, and they expected to serve us in the same manner.

The Spanish lieutenant and his men had been prisoners for thirteen months, having been captured when attempting to reach Manila after the evacuation of the Cavite arsenal. They were very bitter against the Insurgents. Their physical condition and their clothing did not indicate very kind treatment. It was really quite touching to hear their expressions of delight and gratitude over being in friendly hands once again and to see their eyes fill with tears as we steamed up the Pasig and they caught sight of the "Stars and Stripes" proudly floating from the staff where previously they had seen the flag of Spain.

General Otis sent word to the commander-in-chief of the fleet that there would be no general advance of the army in the direction of the Zapote River next day (Tuesday), as it was necessary to send reinforcements and supplies to Las Piñas. However, General Lawton decided to make a reconnoissance, the next morning, of the approaches to the Zapote River bridge, and the ships were ordered to clear the way for his scouts. The advanced scouts were to carry signal flags to mark their positions, and to serve as guidance for the ships in firing. The early morning of June 13 found the flagship Baltimore protecting the city of Manila; the Monadnock between Las Piñas and Zapote River; the Helena directly off the Zapote River; the Manila, Lt.-Comdr. A. P. Nazro, between the Zapote River and Bacoor; the Callao off the mouth of the Imus River; the Monterey and Princeton protecting the Naval Station; while the Wheeling, Basco and Urdaneta were controlling the Isthmus.

General Lawton made an early start on his reconnoissance on June 13, being accompanied by his adjutant-general and two companies of unmounted troops. The ships were soon underway to take positions covering his advance. The Helena's light draft permitting her to go very close inshore, she forced her way slowly through the soft mud and shelled the beach ahead of the scouts. Soon after the Helena opened fire, the much-talked-of six-inch rifle of the Insurgents fired on the Callao and on the Naval Station. One shell ricochetted over the Callao, while another struck the shears at the Naval Station, failed to explode and dropped into a coal-pile. The moment the enemy's gun fired and disclosed its masked position, the Monterey, Princeton and Callao opened such a terrific fire upon it that it was abandoned after its second shot. This gun was mounted in a nipa hut at the mouth of the Imus River, where the Spaniards formerly had a fort and magazine. The Monterey also opened on the two muzzle-loading rifles and disabled them before they fired a shot. One twelve-inch shell from the Monterey completely buried one of the guns, and then on the ricochet took out the end of a church in the rear.

The ships commenced firing all along the line, and the Insurgents opened on them from their beach-trenches. The Mauser bullets were snipping the water and flattening themselves against the sides of our ships, while we were paying our respects with shrapnel, machine guns, and Lee rifles.

General Lawton's reconnoitering party advanced steadily along the beach and planted their signal flag on a point near the mouth of the Zapote River, when suddenly they encountered a strong force of Insurgents in concealed trenches. A hot fire was poured into them from the enemy's trenches, and after a stout resistance, they rallied on the point and lay down on the sloping beach. General Lawton left his men in command of his adjutant-general to hold this strategic and advanced position, while he hurried back to order a general advance of his main force. The Helena, Monadnock and Manila were firing briskly over the heads of our troops into the Insurgent trenches, and their fire was being returned in spirited volleys. The commander-in-chief, accompanied by Captain Forsyth and the writer, was steaming from ship to ship on the firing-line in the little tug Barcelo, and had just left the Helena about the noon hour, when the army's advance guard signaled that vessel: " send support if possible," and followed with a message that they had very little ammunition and no water. Without interrupting their fire, the Helena and Monadnock immediately called away landing parties, and within ten minutes' time had a force of ninety men armed as infantry, and with a Colt gun, on their way to the shore. The little gunboats and ships' armed launches went close in shore and covered the immediate landing with their machine guns, while the ships threw shrapnel over and beyond them. Lieut. Edw. Moale commanded the Helena's landing force, Lieut. F. R. Payne that from the Monadnock, while Lieut. Cleland Davis, with the Helena's steam launch, ably assisted their landing.

In a remarkably short time our men had landed, reinforced the army's small advance guard, and opened with their Lee rifles and the Colt gun. The Helena also sent water and bread to the soldiers on the beach, and her boats brought on board some of the army's wounded. The rapid landing of the forces from the Helena and Monadnock illustrated the high state of efficiency of the vessels, and there was not a mishap to mar its success.

Spirited firing continued throughout the afternoon, but the *combined force* on the beach supported by the ships held the superior force of the enemy in check. In the meantime, General Lawton's main force was advancing, and between four and five o'clock he struck the Insurgents' trenches along the Zapote River. Soon the fierce fusillade was intermingled with wild cheers, and we knew that our troops had assaulted the enemy's stronghold. The Insurgents retreated from the trenches near the beach, and the men of our landing party advanced with their companions of the army to the banks of the Zapote. The enemy withdrew rapidly in the direction of Bacoor, and our ships severely harassed their disorderly retreat. The landing force returned to their ships about dark without a casualty. General Lawton sent the following signal to the Monadnock (the vessel nearest the army signal station) for transmission to the commander-in-chief: "Battle carried the bridge, crossed the river; enemy completely routed. I appreciate assistance of the navy which I will with pleasure acknowledge later officially. Lawton, Major-General commanding."

General Lawton's forces rested for the night in complete possession of the splendid fortifications along the Zapote River. General Lawton and his adjutant-general were most generous in their commendation of the navy's work, and seemed exceedingly grateful for the landing force which so quickly reinforced the exhausted reconnoitering party on the beach, and supplied them with water and bread. It was stated that the fire of the ships and the combined force on the beach held one thousand Insurgents in check in the beach-trenches and prevented them from joining the main line of defense—thus enabling our troops to break through the gap in the enemy's line and enfilade the trenches. Thus, the holding of this advanced position proved the key to the Insurgent trenches; and General Lawton's skill in so quickly taking advantage of the situation achieved a brilliant victory.

Even that admirable soldier and veteran Indian fighter, General H. W. Lawton, regarded this as one of the most severe engagements of his life, the Insurgents having stubbornly held their trenches until our troops charged, and enfiladed them at very short range with artillery fire.

Filipino prisoners and escaped Spaniards estimated the enemy's loss at two thousand killed and wounded—but it was probably one-half that number—and they reported the Insurgents completely demoralized and retreating through Bacoor.

Without doubt, this was the most severe battle of the insurrection, and, although the Filipinos fought courageously, they could not withstand the terrific onslaught of General Lawton's columns and the withering shrapnel and machine-gun fire of our ships.

During the night of June 13, the search-lights of our vessels detected squads of retreating Insurgents, and an occasional shrapnel dropping in their midst made their retreat more precipitate.

Early next morning the native market-boats reported Bacoor abandoned and the enemy retreating to Imus; also, that many had been killed or wounded by the shrapnel fire of the ships. Later in the morning, a boat from the Helena landed at Bacoor and found the outposts of General Lawton's division. Much damage had been done by our ships, and a number of the enemy's dead had been left behind.

While the navy's main firing-line was engaged off Zapote River, the Wheeling was again shelling the returned Insurgents out of the trenches beyond the Isthmus of Dalahican. She drove them out, and then her armed steam launch steamed close along the shore and drove them beyond the range of her machine gun.

It was not many days before Imus, the former capital of Cavite Province, was occupied by General Lawton's forces. At last, the shore-line between Manila and the Cavite Naval Station was clear of Insurgents. The gratifying result of the campaign in Cavite

Province proved the splendid cooperation of the army and the navy in a campaign where success depended upon efficient cooperation.

For some unaccountable purpose the newspapers of Manila barely mentioned the presence of a few ships during the Zapote River campaign, and though our home papers contained many vivid descriptions of the land operations in this campaign, the navy's thorough and invaluable cooperation has not been published.

The Insurgents' gun and the shell it landed in the Cavite Naval Station will soon occupy a place among the war trophies at the U. S. Naval Academy.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE LANDING AT BAIQUIRI.

By JEAN LEGRAND.

"La Marine Francaise," June, 1899.
Translated by Lieut. F. A. Traut, U. S. N.

Nearly a year ago, we called attention in this Review to the fact that the disembarkation of the body of troops which brought about the capitulation of Santiago was much inferior, both as to preparation and execution, to similar operations carried on by the Japanese in their recent war. We now return to this subject, being amply supplied with official information: the study of the errors committed by others should teach us to be on guard and to pledge ourselves not to improvise solutions of problems which, in spite of the conference at the Hague, will present themselves in the future.

The original plan of the Americans seems to have been to attack and to reduce Havana. The news of the departure of Cervera's squadron interrupted their preparations; on the third of May, Long telegraphed to Sampson that nothing would be done until it was known where this squadron was going. If its objective was Puerto Rico, it would be there about the 8th of May and should then be attacked at that place. The conference at the White House had fixed upon 40,000 men as the strength of the expeditionary corps, which, it flattered itself, could be organized in fifteen days; then, after the 15th, orders were given countermanding this. The uncertainty which governed Cervera's plans prevented carrying out the preparations which had been begun. In the meantime, on the 20th the War Department expected soon to have thirty transports at its disposal at Tampa.

Just at this time news is received of the presence of Cervera at Santiago, and with a perfectly clear conception of the situation, it is decided that his ships must be captured there, and that, furthermore, an expeditionary force capable of reducing the city must be transported.

On the 31st, the Navy Department inquires of the War Department as to the ways and means which will be employed for the landing of the troops and war material, and advises it that the crews of the men-of-war cannot be detached for this purpose from their duties on board ship, where they are awaiting opportunity of offering battle to the Spanish admiral.

The expeditionary corps, estimated at 25,000 men, is waiting only, it is said, to be assured that the whole of the enemy's squadron is really in Santiago, before putting to sea.

Commodore Remey, commanding the naval base at Key West, organizes the escort. He sends only a few ships to Tampa, in order that they shall not exhaust their supplies. The others are to join at Tortugas.

Elsewhere, Commodore Watson, who is blockading the north coast of Cuba, redoubles his vigilance, in order to oppose any sortie of the Spanish gunboats.

On the 2nd of June, General Shafter announces that he will sail in two days, when the strength of his forces shall have reached 18,000 men (there was talk of 25,000 the week before!).

Measures are taken to prevent the curious, notably the press-boats, from following the convoy. They are to be kept away.

Information is obtained regarding the strength of the enemy, who is said to have 7000 men at Juraguacito, otherwise known as Siboney, 5000 at Morro-de-Cuba, and 900 men in detachments in the batteries and with 37 mm. Hotchkiss guns and torpedoes. It is to be noted that, in reality, the forces stationed in the province did not exceed 8000 men and that Santiago was defended by 2968 men, to-wit:

	Men.
Landing parties from the squadron	458
Four companies of the battalion of Puerto Rico	450
Battalion of Talavera	850
Four companies of San Fernando	440
Three companies of "mobiles"	330
Finally, the volunteers	440
Total	2968

Be that as it may, on the 7th of June, Sampson telegraphs from Santiago: "We have bombarded the forts from 7 until 10 o'clock in the morning and have rapidly silenced their fire, at 2000 yards, without receiving any damage. If there were 10,000 men here, the city would be ours in 48 hours!"

The army is just about ready and the escort awaiting impatiently the signal of departure, when there is a sudden alarm in the form of a telegram from Remey, on June 8:

"A Spanish armored cruiser, a second-class cruiser, and a destroyer have been sighted by the Eagle, near Nicholas Channel, and several hours later the news was confirmed by the Resolute, which has arrived. She was chased by the two ships last night. Shall I send the Indiana and all available cruisers in reconnaissance?"

Under the influence of this sudden surprise, people ask if Sampson has not allowed some vessel to escape; he is enjoined to send back his two armored cruisers.

Here are the details of the appearance of those two phantom vessels: At 9.45 in the evening, the Eagle sighted the stern light of an armored cruiser; she twice makes the signal of recognition, the other displays lights which are answered by a protected cruiser and two destroyers. The Eagle steamed up abreast of them until it was certain that they were Spaniards. She communicated with the collier Lebanon, telling her to notify Sampson, and then returned as quickly as possible to Key West. One of the torpedo-boats chased her for some time . . .

Here is evidently a disagreeable *contre-temps*, but upon considering the matter, it can be disposed of by reinforcing the convoy. Remey has the sea searched in every direction. Officers even land on the Cuban coast, searching for information.

On the 8th, the Department, with great good sense, demands certain explanations. How were the ships in question recognized as being Spaniards, or as armored or unarmored? And here already we have the Resolute less affirmative—she saw nothing but lights. But the other one holds out; captain, officers, crew, all are agreed, having observed the enemy for half an hour at the distance of a mile.

Immediately, a monitor is despatched to Havana, the cruisers at Tampa are reinforced to the number of four, and a field battery is established at the end of the jetty!

On the 10th of June, Sampson replies in the most sceptical manner, all the time inveighing against the unforeseen delay.

Finally, on the 12th of June, it is announced that the vessels seen by the Eagle were the Armeria, Scorpion, and Supply, which had been exactly in that position at the time specified.

Finally, on the 12th of June, there are thirty-seven transports and lighters gathered at Tampa. A new delay which is now to occur is caused by the difficulty experienced in renewing their supply of fresh water. They are protected by the Annapolis, Castine, Helena, Hornet and Resolute.

They are to rendezvous at Rebecca Shoals with the Indiana, Detroit, Bancroft, Wasp, Eagle, Osceola, Wompatuck, Manning and two torpedo-boats, the Ericsson and Rodgers. It will be necessary to keep a sharp lookout. It is reported that there are five small Spanish cruisers at Puerto Rico!

And, in the meantime, the battalion of marines landed at Guantanamo is pressed so closely that Sampson makes the most urgent demands for reinforcements.

Finally, at half-past eight on the evening of the 15th, the transports arrive in disorder, at seven knots' speed, at the rendezvous where the convoy is awaiting them. Every night, the column is so extended that the end is lost sight of; a lighter with a pair of sheers and a tank-vessel, which are being towed, cause continual trouble. The commander would like to close the intervals, but this cannot be done until clear of the Bahama Channel.

The mules on board the Julia are dying of thirst. The City of Washington loses the rest of the convoy and is only partly reassured by the presence of the Bancroft. On the 18th, they both sight a large steamer coming towards them. Instead of answering signals, she goes about. She is fired upon and decides to tell who she is. It is the Yucatan, with the Rough Riders, sent, it appears, by the commander in search of the stragglers. It is more than likely that these gentlemen were in search of "excitement." Needless to say, Captain Taylor, the commander of the convoy, knew nothing of this pretended mission. As for him, he was very much occupied in having the coast-line watched by one or two cruisers. Commodore Watson, in person, cruised for two days with the Montgomery inshore of the convoy.

Finally, one thing helping another, on the morning of the 20th, sixty vessels stopped 15 miles off Baiquiri.

Admiral Sampson's chief of staff, having come out in the Gloucester, conferred with the commanding general.

He brings with him a chart and explains to the general that in order to enable the squadron to go in, it will be necessary to take the positions occupied on both sides of the harbor entrance by the enemy's batteries.

The possession of these points will ensure the destruction of the torpedoes and the attack upon Cervera at the anchorage. General Shafter acquiesces in this plan.

Baiquiri was then definitely fixed upon as the point of disembarkation. The transports were assigned their stations. The men-of-war were assigned the duty of getting them into this formation and of rectifying it at all times.

In the meantime, the convoy was covering itself with signals of distress, asking for the fresh water which the tank vessel was distributing. The convoy lay to all night and there ensued an indescribable confusion.

The next day, the commanding general wished to call the corps and division commanders on board the Seguranca, but no one paid any attention to the signals. Quite late in the afternoon, it was found necessary to have the Bancroft make a round of the ships; and with the greatest difficulties, on account of the state of the sea, she took on board a dozen officers who were little familiar with that sort of operation. Two of them tumbled into the water. Colonel Van Horn, having misjudged his time, let himself drop from the height of fifteen feet into the boat—he subsequently died from the effects of it.

The conference finished, the next thing was to get back to their respective ships. But the captain of the Indiana had decided to keep underway during the night—steaming towards the southward until midnight—for the purpose of maintaining some sort of order.

It thus became a most dangerous operation to have these vessels stop, in column, after having found them by the aid of a search-light. The colonels and generals had to resolve themselves to pass a most uncomfortable night on board the Bancroft.

Meanwhile, General Shafter had notified the admiral of his intention to commence disembarking his troops. Sampson directed the captain of the St. Louis to proceed with the latter, using the following boats:

St. Louis, 13 life-boats, 10 collapsible boats;
Massachusetts, 2 steam launches, 5 cutters, 2 whale-boats;
Iowa, 2 steam launches, 1 whale-boat;
Brooklyn, 2 steam launches, 1 sailing launch, 3 cutters;
Oregon, 2 steam launches, 1 sailing launch;
Annapolis, 1 steam launch;
Indiana, 1 steam launch;
Detroit, 1 steam launch;
Texas, 1 steam launch, 1 cutter.

Namely, 12 steamers for towing, 3 sailing launches, 10 cutters, 4 whale-boats and 23 boats from the St. Louis. Total, 52 boats.

* It is to be noted that the squadron could and, perhaps, should have furnished many more. This depends on whether the length of shore-line available for disembarkation would have permitted their use.

The captain of the St. Louis had made the disposition set forth in the following order:

1. The boats of the squadron assigned to the duty of landing the army will assemble near the St. Louis, off Baiquiri, at 4.30 A. M. The senior officer in charge of the contingent from each ship will report on board the St. Louis for orders.

2. Each boat will have a coxswain and from two to four men, according to size. They will be provided with an answering pennant on a staff.

3. The officers in charge of boats will repair alongside the transport designated in their written orders and will embark passengers in the boats, approximately as follows: steam launches, 15; sailing launches, 70; life-boats, 45; cutters, 25; whale-boats and gigs, somewhat less.

4. The boats will be loaded carefully; the first men coming on board will be required to sit down in the bottom of the boat. Those on the thwarts will, under their officers, be prepared to fire on the enemy. Avoid overloading the boats.

5. As the boats are loaded, they will push off and be taken in tow by the steam launches. The steam launches will then form in line abreast, to the southward of the Wompatuck.

6. The heavier boats will go next the steam launches.

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* All other boats were left at Key West.—EDITOR.

7. When the blue-peter is hauled down on board the Wompatuck, the flotilla will follow in her wake.

8. It is intended to prepare a landing-stage, to be towed by the Wompatuck. If this intention is realized, the troops will debark on the stage. Possibly, a pier now existing at the point selected may be available. Or, if it cannot be arranged otherwise, the troops will land from the boats directly.

9. In any event, a blue and red flag hoisted on the Wompatuck will be the signal to land, when the detachments will go ashore in the following order: first, that from the Seneca, in the order designated by Colonel Van Horn; second, that from the Arizaba (24); third, that from the Manteo (36); fourth, that from the Knickerbocker (13); that from the Iroquois as directed by General Lawton.

10. The boats awaiting their turn at landing, and especially the steam launches with their rapid-fire guns, will clear the vicinity of the beach of the enemy.

11. An orderly and deliberate procedure in disembarking will be found an economy of time. If there be any surf, the army officers in the boats will designate their men by name in the order of disembarking. The officer or coxswain of the boat will provide for this before leaving the transport.

Let us see how this program was executed.

At 4.30 in the morning, the St. Louis went within a mile and a half of the harbor of Baiquiri, in order to show the transports that there was sufficient depth of water. The boats did not arrive until two hours later, in tow of the Suwanee and Wompatuck. Some of the steam launches even came under their own steam. It was not until nearly nine o'clock that an advance upon the landing-place could be contemplated. As soon as the first of the troops were embarked in the boats, the Indiana had hauled down the pennant of the commander of the convoy and had stood towards Santiago, by the express order of Admiral Sampson. Neither men nor officers being familiar with this sort of work, the loading and taking in tow of the boats became a very laborious operation. The transports were lying so far off that much valuable time was lost in getting to them. One of them, the Knickerbocker, failed to appear and the division of boats—composed of 4 steam launches and 11 cutters—which was intended for her 600 men, searched for her in vain. She did not appear until late in the afternoon. The captain of the St. Louis had gone on board the Wompatuck. The prearranged signal was hoisted, and accordingly, the ships New Orleans, Detroit, Castine and Wasp opened a fire on the shore heavy enough to destroy the whole Spanish army,—if it had been there! There was no reply. Besides, this fire would have been incapable of sweeping a country so cut up and offering hundreds of ambuscades from which one could command the wharf in perfect security. The Wompatuck and her satellite, the Suwanee, also fired a few shots into the woods to the west of Baiquiri. Fortunately, there was no resistance, and still more fortunately, the little harbor was found in good condition. On the other hand, it was impossible to get more than two boats alongside at a time and so this operation, hindered by the swell, was discouragingly slow. At six o'clock in the afternoon, there were hardly 6000 men on shore, representing not quite three trips for every boat. There is no doubt that if the transports had not lain from two to five miles out, things would have gone much better. An attempt was made to land directly on the beach, but several boats were thrown upon the rocks and one of them, belonging to the Brooklyn, was completely destroyed. In the afternoon, the beach-master was able to organize a more systematic method of discharging the boats and stopped the transporting of troops in the steam launches, since the latter lost so much time in getting alongside. The following day, the various points were recognized, in regard to which there had been a total lack of preparation, and measures were taken to properly provide for them. General Shafter placed the officers of the merchant vessels under the orders of the captain of the St. Louis, of which the latter took advantage by making them anchor close to the shore, near Siboney, where the disembarkation was to be continued; furthermore, the steam lighter Laura, which carried 300 men, ferried the troops across this short distance and landed them by means of two sailing launches loaned by the navy and directed by Colonel Weston. There was no wharf at Siboney. A normal speed of landing 600 Americans or 1000 Cubans per hour was reached. The wharf at Baiquiri was, moreover, in bad condition and it seems remarkable that no effort was made to repair it or keep it in order, or to see to the building of a new one—like the Japanese under similar circumstances.

The result appeared to be sufficiently satisfactory for reducing the number of steam launches on the 24th to five and to send back the Oregon's boats. The operations were continued during the night, thanks to the search-lights of the St. Louis, which ship, thanks to her resources of all kinds, rendered the most valuable service. She berthed the men from the squadron, hoisted at her davits all the boats not in use, coaled, watered and repaired the steam launches, and furnished them with relief crews of machinists and firemen for night duty. The question also arose of landing the mules of the engineer corps. They had to content themselves with putting them overboard alongside, in the hope that they would gain the shore, but some of them swam out to sea, and since there was no boat detailed to look out for them, they were lost. About fifty were drowned in this manner. As to supplies, ammunition, etc., the landing of these was carried on in an exasperatingly slow fashion and was dependent entirely upon circumstances.

At last, on the 26th of June, in the afternoon, the St. Louis rejoined the squadron off Santiago with all the boats, her special duty having been completed.

From the disorder of this expedition—henceforth a matter of history—we may draw the following conclusions:

1. In a convoy, there must be unity of command and it cannot be embodied in any one but the commander of the escort.

2. In order to convey his directions to the captains, it will be necessary to have on board of each chartered ship one midshipman and two signalmen.

3. In order to simplify the conduct of the convoy, each man-of-war should have charge of a group of merchant vessels whose movements will be regulated by her.

4. It is absolutely impossible to take along such floating material as pontoons, lighters, tank vessels, without running the risk of innumerable delays and annoyances.

5. The commander of the convoy must be identical with the officer in charge of the operation of debarkation.

6. Unopposed landings only should be attempted.

7. The speed of the operation is a function of the distance to the landing-place and of the relative number of boats and length of available landing-place.

8. A body of troops is landed, for the purpose of taking posses-

sion of a port, and, in this port are subsequently landed the artillery and stores of this body of troops.

9. In order to carry out a successful debarkation, it is necessary to have practiced it before—under any other conditions, the most minute theoretical preparations will not accomplish the end in view.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE WAR AND ITS LESSONS.

By Colonel Sir G. S. Clarke, K. C. M. G., F. R. S.

The year 1898 saw the English-speaking peoples engaged in warlike operations in regions widely separated. The conditions of the contests differed organically; but the objects were essentially similar. In both cases, strikingly complete success was attained, and while the disappearance of the remnants of the colonial empire of Spain is fraught with far greater consequences to the world than the overthrow of Dervish rule in the Eastern Sudan, the principal result is to increase the responsibilities of nations owning a common origin and upholding a common standard of progress and of liberty. This fact alone suffices to invest the wars of 1898 with peculiar significance, and to render their lessons specially important to the two English-speaking peoples.

From the days of the Armada, it has been the ill fate of Spain to be frequently brought into collision with the British Navy. This has been caused directly by the struggle for colonial dominion which, beginning in the days of Elizabeth, assumed great dimensions in the wars of the 18th century, and indirectly by French alliance, voluntary or enforced, which have entailed nothing except loss of territory and naval disasters upon Spain.

The conquest of Jamaica by Penn * and Venable in 1655 marked the dawn of the expansion of England. It is an exceedingly interesting historical development that the over-sea expansion of the great nation which owes its birth to England should have followed similar lines. The events of 1898 offer another an-

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* Father of the founder of Pennsylvania.

alogy with the older Spanish wars. The story of Jenkyns's ear was probably a fable; but it is clear that accounts of Spanish cruelties and especially of the enormities alleged against the Inquisition which Spain imported into her colonies powerfully impressed the imagination of the British people and aroused their strong resentment. The spectacle of hopeless misrule of Spain in Cuba, with the wanton destruction of life and property which it entailed, forcibly appealed to the humanitarian instincts of the American people. A great nation cannot continue to contemplate with equanimity chronic disorder in closely adjacent territory with which its interests are closely involved, and intervention sooner or later was obviously inevitable when the destruction of the Maine, lying at anchor under the protection of the Spanish authorities, precipitated the issue. No government could resist the popular will in such a case and on April 21, Congress declared war.

The theatre of operations by sea and land is classic in British history. The West India Islands and the waters of the Caribbean Sea had been the scenes of innumerable military and naval conflicts. Manila, San Juan, Havana and Santiago had all been attacked, and Santiago alone had escaped British occupation. Almost exactly 301 years before Admiral Sampson's squadron arrived off San Juan, the place was captured by the Earl of Cumberland after operations closely resembling those recently carried to success at Santiago. San Juan, in 1597, is described as being "very much bigger than all Portsmouth within the fortifications and in sight much fairer." Its defenses were reported "to the sea very strong and fitted with goodly ordnance, and bestowed for the most advantage to annoy an enemy that can possibly be devised." The ships, therefore, made no attempt to enter the harbor, and success turned upon the land attack. The Spaniards, said the British commander, "will make a great show, and perhaps endure one brunt; but, if they do any more, tear me to pieces." After the occupation of the town, the garrison of the Morro accepted the following terms of capitulation:

> A resolution which you may trust to. I am content to give yourself and all your people their lives; yourself with your captains and officers to pass with your arms; all the rest of your soldiers with their rapiers and daggers only. You shall all stay here with me till I give you passage from the island, which shall be within thirty days.

This arrangement of 1597 finds a close parallel in 1898. In 1757 and again in 1762, Manila was taken by a British force. On the latter occasion, 10 ships of war under Rear-Admiral Cornish and a landing force of 2300 men under Colonel Draper were employed. The town itself was ransomed for four million dollars, of which the Spaniards only paid half. The Filipinos of this date, armed with bows and spears, are said to have displayed great fighting qualities on the Spanish side and to have " boldly rushed on the very muzzles of our pieces." About the middle of the 18th century the possession of Cuba seems to have been ardently desired in England. " Take and hold, is the cry," wrote William Pulteney to Admiral Vernon in 1740, " this plainly points to Cuba, and if the people of England were to give you instructions, I may venture to say, ninety-nine in a hundred would be for the attacking of that island." The combined expedition under Vernon and General Wentworth, after failing in an attempt to take Cartagena, was directed against Santiago, in July, 1741, in defiance of sound principles. A considerable Spanish squadron lay at Havana which was watched by cruisers. The landing was effected in Guantanamo Bay and a hundred American troops were the first to be put on shore. The military forces remained for three months in the neighborhood of Santiago; but nothing was accomplished, and after mutual recriminations between the admiral and the general, the expedition was ignominiously withdrawn. The Spanish squadron at Havana maintained a masterly inactivity and there is little doubt that Santiago could have been taken; but the conquest would have been unimportant. In April, 1748, Santiago was again attacked by Rear-Admiral Knowles with eight ships fresh from the capture of Port Louis. Captain Dent of the Plymouth, 60-gun ship, led in towards the harbor, but the Spaniards had blocked the channel with a boom, and after a fruitless engagement with the forts, the squadron withdrew. For this failure Captain Dent was tried by court-martial and acquitted. In June, 1762, Havana was attacked by Admiral Sir G. Pocock and an expeditionary force of 10,000 men under the Earl of Albemarle. American troops from New York arrived later * and took part in the siege of the Morro. On July 1, the Cambridge (80), Dragon (74) and Marlborough (70) engaged the

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* The American contingent " came very seasonably and was of great service."—*Annual Register.*

1.68
.41
2.09

1.04
.23
1.27

defenses for seven hours and were withdrawn much damaged with a loss of 176 men. On July 30, the Morro was stormed and on August 13, Havana, with nine ships of the line, capitulated. By the Treaty of Paris in the following year, Cuba and the Philippine Islands were handed back to Spain in exchange for Florida and the right of cutting logs in Honduras. Destiny, foiled in 1763, has now reasserted itself, and the future of Cuba and of the Philippines rests with the English-speaking peoples. The American troops who landed in Guantanamo Bay in July, 1741, were the precursors of the marines who disembarked on the same shore on June 10, 1898.

The primary conditions on the outbreak of the war of 1898, were comparatively simple. Foreign complications could be safely ignored in view of the attitude of Great Britain and of the extreme reluctance of European powers, harboring pro-Spanish sympathies or designs upon Spanish territory, to take any step which might lead to a British naval demonstration. This, however, was not at the time realized in the United States. The objects of the war demanded intervention in Cuba. Havana, the center of Spanish power, was therefore, as in 1762 and as ought to have been the case in 1741, the primary objective. Until the naval situation was assured, however, nothing could be attempted on Cuban soil, nor could the maintenance of an effective commercial blockade be counted upon. Such is the plain teaching of all history. The Spanish ships of war in Cuban ports could be safely disregarded, and the main question, therefore, was as to the measure of naval strength which Spain could bring to bear in West Indian waters from her home ports, 4000 miles across the Atlantic. Accurate information of the state of the Spanish Navy was unquestionably available at Washington, although the hopeless unpreparedness since revealed may not have been fully realized. If the Spanish fleet had approximated in reality to its paper strength, the task of contending with the American Navy in its own waters would have been difficult. In the actual conditions, that task was impossible; but an inferior fleet well found and well handled is capable, until defeated or closely blockaded, of preventing such operations as the United States were called upon to undertake in Cuba. Was this minor task possible to the Spaniards?

At the moment when war was declared, Admiral Cervera's squadron of four armored cruisers, three destroyers and three torpedo-boats lay at St. Vincent, Cape Verde Islands. The Spanish government had apparently already decided that it was necessary, for political reasons, to send a naval force to Cuba; but this was not known to the admiral, who wrote on April 22:

> It is impossible for me to give an idea of the surprise and astonishment experienced by all on the receipt of the order to sail. Indeed, that surprise is well justified, for nothing can be expected of this expedition except the total destruction of the fleet or its hasty and demoralizing return; when here in Spain it might be the safeguard of the nation.*

The state of the squadron amply justified this forecast, which was perfectly accurate except that a "demoralizing return" was exceedingly improbable. Even ships so little fit for purposes of war as those of Admiral Cervera would have been of value in protecting the coast-line of Spain from a raid across the Atlantic such as naturally presented itself to the minds of instructed Spanish officers. After a delay of eight days, which told its tale to cool observers, the Cape Verde squadron went to sea.

In the United States, the most exaggerated fears found expression. The Atlantic seaboard was assumed to be in danger and panic measures were adopted. Writing in 1897,† Captain C. F. Goodrich, U. S. N., gave specimens of the flood of excited telegrams which invaded Washington in 1861-63, and drew attention to "the wisdom and firmness displayed by the Secretary of the Navy . . . Mr. Welles's contention was, in effect, that the harbors of New York and Boston were guarded by the vessels of the blockading fleet which stretched from Cape Henry to the Rio Grande, a surprisingly broad and sound strategic view, from which he appears never to have wavered." At the same time, Captain Goodrich expressed a doubt "whether, in the event of war in these days, a Secretary of the Navy can possibly be as independent in his action as was Mr. Welles." By far the most important lesson of the war—to the United States and to Great Britain—is the danger that uninstructed public opinion may usurp the direction of naval policy. At the beginning of this century the people of England had learned by experience many of the principles of naval war; but tendencies, such as were manifested in 1898, had not been wholly extinguished. "Only think," wrote Reppel to Saumarez, "what alarms we shall have and how much our cruising will be interrupted if any more invasions are trumped up, which they will be in the winter, so that their (the French) Martinico ships may pass safe." Similarly, Lord St. Vincent significantly complained of the influence exerted by "the fears of the old women of both sexes." In 1898, public opinion, not strategic principles, determined the preliminary naval proceedings of the United States in the Atlantic. Governments, like those of Russia and Germany, which are not accessible to the influence of a popular outcry, have an undoubted advantage in conducting operations of war.

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* Papers translated in the office of Naval Intelligence.

† *Naval Raids.* Proceedings U. S. Naval Institute.

At the end of April, the naval attitude of the powerful belligerent was one of anxious and passive expectation, while its weak and ill-prepared opponent was undertaking what appeared to be an offensive movement into far distant waters. At the same time popular opinion in the United States, though powerfully impressed with the idea that New York, Boston and Philadelphia were in imminent danger, demanded an immediate invasion of Cuba, and 5000 picked regular troops were prepared for embarkation. If the naval situation had really been such as to imperil the Atlantic coast-line, it would have been madness to have undertaken over-sea operations, and the project of sending the first expeditionary force to sea on May 4 was abandoned.

It is abundantly clear that American naval officers were not in the least imbued with the prevailing alarms, and as early as April 9, Admiral Sampson, with the true instincts of the sailor, wrote to the Secretary of the Navy:

> I sympathize with all you say about guarding our big ships against a possibly serious loss while the enemy's fleet is still intact. At the same time, I regard it as very important to strike quickly and strike hard as soon as hostilities commence.

Popular theories of the potentialities of the Spanish fleet, however, forbade any strong naval measures, and in deference to these theories the United States force was divided, the Flying Squadron being retained at Hampton Roads in the hope of allaying the fears of the press and the people. The genesis of the Flying Squadron may in fact be traced to an uninstructed outcry. On April 29, Admiral Cervera sailed, and with an ocean speed of

10 knots only could have reached San Juan on the 9th of May. On this date, Admiral Sampson was proceeding slowly to Puerto Rico much hampered by the monitors Terror and Amphitrite. Commodore Schley was at Hampton Roads and a weak blockade of Havana and part of the Cuban coast-line existed. The object of Admiral Cervera was merely to evade the United States Navy and to reach a Cuban port. He, therefore, avoided San Juan and steamed straight to Martinique, arriving off the south side of this island on May 12 and, after communicating with Fort de France and leaving there the destroyer Terror, he proceeded to Curaçoa. Here he missed a collier which had been directed to meet him and steaming northwest arrived at Santiago on the morning of May 19. His squadron was sighted off Martinique by Lieut. Kane of the U. S. S. Harvard, and reported by telegraph. Its arrival at Curaçoa was notified by an American passenger on board a British steamer. Important news was thus obtained mainly by good fortune. The evident want of system in the scouting operations was doubtless due to the fact that they were not controlled by the commander-in-chief alone. If a mixed control had not been substituted for unity of command, Admiral Cervera's squadron would probably have been sighted before it reached Santiago. Meanwhile, on May 12, when Cervera was nearing Martinique, Admiral Sampson was bombarding the defenses of San Juan. Neither reason nor the experience of war justified any hope of effective results and, if the Spanish gunners had known their trade, the United States ships would unquestionably have suffered injuries which might have proved exceedingly inconvenient. As it was, the admiral withdrew after a large expenditure of ammunition and reported "the United States fleet in great need of repairs," while the Spaniards were enabled to claim a victory. If the squadron had been well to the eastward when war was declared and had struck at San Juan on April 23, when the Spanish preparations were in a backward state, a success, which would have had definite strategic significance, was perhaps possible.

The important news from Martinique and Curaçoa caused a rapid change in the situation. The Flying Squadron could at length be moved south, and after coaling at Key West, it sailed for Cienfuegos on May 19, at the very moment when Cervera was entering Santiago, and was followed next day by a reinforcement consisting of the Iowa and Castine with the collier Merrimac. Admiral Sampson's force, which had returned to Key West, sailed on May 21 to join the Havana blockade, receiving news on the 22d that the Spaniards were at Santiago on the previous day. On May 23, the squadron steamed eastward and cruised in the Nicholas Channel in order to cover the approach to Havana, returning to Key West on May 28. Meanwhile, Commodore Schley remained off Cienfuegos from the 22d to the 24th, and then proceeding eastward executed some complicated manœuvres off Santiago, ultimately approaching the harbor on the 29th and at length sighting the Spanish squadron inside.* Admiral Sampson arrived on June 1, and, the Oregon having previously completed her fine voyage, the battle fleet of the United States was now massed off Santiago.

The naval situation between May 16, when the Spaniards left Curaçoa, and June 1, when the close blockade of Santiago was established, is extremely interesting and instructive. If Cervera had made for Cienfuegos, he would have encountered the Flying Squadron. If he had steamed for Havana by the Yucatan Passage, he would have arrived without meeting any serious opposition, and the later proceedings would have been widely different. Cervera, however, short of coal and painfully conscious of the grave defects of his force, simply sought the nearest Cuban harbor. His entry into Santiago was at once reported; but nine days elapsed before any hostile squadron approached within 30 miles of the port, and on May 28, Commodore Schley reported, " Much to be regretted, cannot obey orders of Department. Have striven earnestly; forced to proceed for coal to Key West." At Santiago, on the other hand, there were 3500 tons of coal,† and although appliances for putting it on board were deficient, a more energetic people than the Spaniards would doubtless have found means of filling the bunkers of the cruisers and getting them to sea several days before the United States Navy was in a position to blockade. The dominating influence of coal-supply upon naval operations received a striking illustration.

Another point is well worth notice. In times of peace we are wont to assign strategic importance to various positions in ac-

* Admiral Sampson seems never to have doubted the information that the Spanish squadron was at Santiago.

† Lieut. Müller y Tejeiro.

cordance with academic considerations. In naval war, the position of supreme importance is that of the enemy's fleet. Thus Santiago, previously unconsidered, became on May 19 the *crux* of the naval and military situation, and such was the irony of events that Cervera's movement from Cape Verde Islands, which had caused panic on the Atlantic seaboard, turned absolutely to the advantage of the United States.

Much has been written about the difficulties of modern blockades, and doubtless with a view to mitigate the harassing strain upon the fleet, Admiral Sampson on May 27 * determined to obstruct the channel leading into Santiago harbor. On the night of June 3, the attempt was made by Naval Constructor Hobson and seven volunteers. It was a gallant act, worthy to rank with the highest deeds recorded in naval history; but the failure to sink the Merrimac in the fair-way was most fortunate. If the Spanish squadron had been imprisoned, its whole resources, like those of the Russian Black Sea fleet in 1854, would have been available for the land defense, and the subsequent difficulties of the military expedition would have been immensely aggravated. The Merrimac plan conflicted with the teaching of naval history and its failure was an unqualified gain.

The navy having established its blockade, it was necessary, as in all such cases, for the army to act, and Admiral Sampson at once asked for 10,000 men to take the works commanding the entrance to the harbor. The expedition was to have embarked on June 8, when a rumor arrived that an armored cruiser had been sighted by the Eagle off the north coast of Cuba. Admiral Sampson "placed no confidence whatever in this information"; but a delay of several days, which he justly characterized as "most unfortunate," was entailed, and the incident is vastly significant. Reluctance to send a military expedition to sea, when a possibility of encountering an enemy's ships existed, was always manifested in sailing days and is now far more than ever justified. A most improbable rumor has, however, rarely proved so potent as in this case. While the expedition was being held back, Admiral Sampson, strictly following the precedent of 1741, occupied Guantanamo Bay and landed a battalion of marines. Few harbors could be more easy to blockade than Santiago, where the channel of exit is narrow and tortuous while the coast batteries were wretchedly made and the gunners hopelessly incompetent. Yet, as Captain F. E. Chadwick shows,* the possession of a neighboring harbor was almost absolutely essential for the work which had to be carried out by the powerful American fleet. A finer body of troops than the 13,000 regulars who formed the bulk of the expedition has rarely landed on a hostile shore; but, like the British force which invaded the Crimea in September, 1854, it was an aggregate of brave men rather than an army. Admiral Sampson's plan, which offered few difficulties, was now unaccountably abandoned, and while the military commander-in-chief remained on board ship, his troops moved inland to the attack of the town of Santiago. Transport, adequate artillery, and organization were alike wanting. From the technical point of view, the severe fighting of July 1, like the battle of Inkerman, invites facile criticism. The storming of the positions of El Caney and San Juan, however, showed the qualities of the American infantry in the brightest light, and as has frequently happened in the history of the Anglo-Saxon peoples, conspicuous personal gallantry triumphed amidst difficulties which might have involved disaster. But the cost was heavy and, exhausted after their great efforts, the troops could only entrench themselves in the positions occupied. The intention to assault the town at daybreak on July 2 was, therefore, abandoned and a momentary wave of depression passed over the United States. At Havana, however, the crisis was considered to have arrived and Admiral Cervera, whom the Spanish government with inexcusable folly had placed under the order of the military commander, was directed by telegraph to go to sea within twelve hours. Good gunnery—the best defense of a ship as Farragut insisted—and high speed could alone provide a chance of escape. The Spanish squadron was deficient in both, and within four hours it met with the "total destruction" which its admiral had anticipated. The running fight of July 3 strongly resembles that of Sir John Duckworth with the squadron of Admiral Leissègnes off San Domingo on February 6, 1806, when two French ships of the line were driven ashore and three captured; but modern conditions hastened and gave a tragic completeness to the issue.

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* On this day the New Orleans was ordered to Santiago with the collier Sterling, which was to be used for this purpose.

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* *Scribner's Magazine*, Nov., 1898.

The minor technical lessons of the action have been frequently pointed out; but the most striking feature was the intense eagerness displayed by all the American captains to bring their ships into action. Here was the true naval instinct which was conferred victory in far more serious contests. The performance of the Oregon is remarkable as showing clearly the effect of the experience and training of the engine-room staff gained in the long voyage from the Pacific.

The navy had brilliantly discharged its task; but the land operations were involved in difficulties daily increasing, and General Shafter telegraphed that "it will be impossible to carry" Santiago "by storm with my present force." That front attacks on prepared positions are precarious, especially when unsupported by a powerful artillery, was abundantly proved during the Civil War before the era of the magazine rifle. This may perhaps have been forgotten and the want of transport and camp equipment seems to suggest that an easy success was anticipated. The troops were now beginning to suffer severely from exposure and insufficient supplies. The experience of the Crimea was repeated on a smaller scale, and in face of an interprising and energetic enemy, the situation would have been serious. The Spaniards, however, remained true to their traditions of not attacking, and were evidently unaware of the critical state of their opponents. The conditions of 1741 were thus almost exactly reproduced, and, to complete the parallel, a marked divergence of naval and military opinion asserted itself. Already, on July 2, Major-General Shafter had urged the admiral to force an entrance into the harbor.

> I urge that you make effort immediately to force the entrance in order to avoid future losses among my men, which are already very heavy. You can operate with less loss of life than I can.

The admiral, however, held steadfastly to his original plan and replied at once:

> Impossible to force entrance until we can clear channel of mines, a work of some time after forts are taken possession of by your troops.

In a letter of the same date, the admiral dealt with the question in more detail and clearly explained the position. At the same time, he expressed his absolute willingness to cooperate as far as naval considerations permitted.

> If it is your earnest desire that we should force our entrance, I will at once prepare to undertake it. I think, however, that our position and yours would be made more difficult if, as is possible, we fail in the attempt.

After the destruction of the Spanish fleet, pressure seems to have been brought to bear at Washington, and the Secretary of the Navy telegraphed as follows on July 13:

> The Commanding General of the Army urges and Secretary of War urgently requests, that Navy force harbor; confer with Commander of Army. Wishing to do all that is reasonably possible to ensure the surrender of the enemy, I leave the matter to your discretion, except that the United States armored vessels must not be risked.

Such differences of view are common in the history of war. Admiral Vernon and General Wentworth had a somewhat violent altercation before Santiago in 1741. Nelson, in the Mediterranean, was obliged to point out to British generals that the powers of ships had limitations. On the other hand, our greatest admiral proposed in 1795 an Austrian occupation of San Remo in circumstances which to most thoughtful soldiers appear prohibitive. Napoleon, who had no time to study naval war, frequently demanded impossibilities of his fleets, and ordered the Allies out of Cadiz to meet destruction at Nelson's hands, precisely as Marshal Blanco dictated to Admiral Cervera, a movement which the latter rightly judged to be hopeless. Wellington in the Peninsula complained bitterly of the want of naval cooperation, ignoring elementary naval considerations as completely as his great antagonist. In 1870, it seems to have been expected that the French northern squadron could effectively attack the Prussian Baltic coast-line, and instances of this kind might be indefinitely multiplied. Officers of the naval and military service are trained in different schools of thought. Neither class can perfectly understand the functions of the other, and military men are peculiarly prone to ignore naval conditions. The United States naval officers had evidently a much clearer conception of the powers and the limitations of naval cooperation than their military comrades. The battle of the Nile is, for all time, an object-lesson of the danger of sacrificing naval considerations to those of military expediency. In free countries, therefore, it may fall to politicians, ignorant of naval and military affairs alike, to adjudicate between the conflicting views of the services. This was fortunately unnecessary in the case of Santiago. On July 11, General Miles arrived and at once proposed to land forces to take the harbor forts; but negotiations were already in progress, and on the 17th Santiago, which had twice defied a British force, surrendered to the United States. In view of the painful position of the gallant troops entrenched before the town, the fall of Santiago was a welcome release from anxiety. The Spaniards might certainly have prolonged their resistance for a short time; but the moral effect of the military surrender following two great naval disasters told heavily at Madrid. Although General Miles with a force of volunteers began his admirably-managed operations in Puerto Rico, the end of the war was at hand, and Santiago, thanks to the squadron of Cervera, proved the decisive point.

Technical lessons are generally far more easily learned and more surely applied than great principles. That inflammable woodwork creates grave danger on board a ship in action we fully recognize. The want of fresh water was most seriously felt by the United States ships * some of which were crippled on this account. "Make up" water must either be carried in the double bottoms of vessels required to keep the sea for a long time, or distilling ships must accompany a fleet. The predilection of the United States for monitors, arising out of the peculiar conditions of the Civil War, will be mitigated now that these craft have proved absolutely unsuited for work at sea. Seagoing and sea-keeping qualities are unquestionably of the first importance in war. Torpedo-boats, in spite of "careful nursing," † at Guantanamo speedily broke down in carrying on the duties of the blockade of Santiago, and their limitations will be duly noted. If, however, they were previously used in some cases for towing coal barges at Key West, the breakdown is partly explained. In their proper *rôle* they were not tried; but it is permissible to believe that men as gallant as the crew of the Merrimac would not—if the opportunity had been given to them —have taken torpedo-boats into Santiago harbor with effect.

The disparity of naval conditions arising from the incompetent administration, the political weakness and the poverty of resources of Spain deprived the war of 1898 of the teaching which might otherwise have been forthcoming. The Spanish Navy was as ill-prepared for a campaign as the French Army in 1870. Thus many of the questions which of late have been eagerly discussed received no elucidation. We may say with certainty that rapid and accurate fire is now, as in old days, the decisive factor in naval warfare. It is significant that a single shell from the armed liner St. Paul put the destroyer Terror out of action at about ten times the effective range of her torpedoes, while the four 6-pounders and four 3-pounders of the yacht Gloucester sufficed to complete the total destruction of the Furor and Pluton.* It is clear that the three destroyers proved a heavy incubus to Cervera's squadron in its passage from St. Vincent. The use of the destroyer, however, is solely in the attack and we have yet to see whether its offensive power will compensate for fragility, and whether it can claim a wider sphere of action than the hunting of the torpedo-boat.

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* But for difficulties thus arising, the Iowa would have been well to the fore in the chase of the Colon.

† Captain F. E. Chadwick, U. S. N.

The grave mistake of placing transports under military authority will hardly be repeated. The supervision of the large number of mercantile steamers which were employed to convey the expeditionary force to Cuba was not the business of soldiers, and many evils would have been avoided by entrusting it to naval officers as is the practice in Great Britain. The proper functions of the soldier end at the shore-line, and when he is permitted, as in 1898, to lay his mines in navigation channels and to flash searchlights at his sweet will, he becomes a public danger. There are special cases in which submarine mines in army hands may be justified; but such cases, in the harbors of great maritime nations like the United States and Great Britain, are exceedingly rare. The mines laid at New York and elsewhere proved an unmitigated nuisance, as might have been confidently expected.

One other lesson may be learned with advantage. The modern craze for coaling stations needs to be abated. The proceedings of the United States Navy in 1898 have clearly shown us that the superior fleet can largely dispense with these luxuries. Guantanamo harbor served its purpose quite as well as if it had been an expensively fortified port in the hands of the United States. Now, as in the old sailing days, bases can generally be extemporized in accordance with requirements. It is upon the effective management of colliers rather than upon coaling stations that a great naval power will depend in war.

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* These two destroyers, however, undoubtedly received punishment from the secondary armaments of some of the heavy ships.

The great principles which the war of 1898 exemplified are old; but they have been frequently forgotten in the past. That the intermixture of politics with naval and military affairs is invariably detrimental and may be disastrous, history has plainly shown. Popular fears and popular fallacies must not be permitted to influence the conduct of warlike operations. Success in war by sea and land is obtained by sea-going and sea-keeping ships, and by organized field forces. The various adjuncts which usurp attention in peace time are of relatively small account. A maritime nation possessed of a large shipping can now as formerly supplement its fleet by vessels which for certain purposes are very valuable; but an expeditionary force with all its manifold requirements is not easily improvised even when the best material is available. Nor can the greatest energy on the outbreak of war atone for want of an organization which is essentially the product of careful study in time of peace. In regard to coast defense, the rich experience of the past has been strikingly reaffirmed. San Juan and Santiago, like Alexandria in 1882, and a hundred other cases, show that ships cannot seriously injure guns on shore. Now, as always, ports containing essential naval resources, or required for the protection of a commercial marine, require defense against naval raids; but the real protection of a coast-line must continue to depend on the mobile navy. The sum which a nation can spare for naval and military purposes is practically limited, and all superfluous expenditure upon coast defense entails loss upon the sea-going fleet and the field army which are the real arbiters of war. This ancient lesson has not yet been wholly assimilated in England where, in recent years, we have seen the fleet starved at a time when superfluous fixed defenses were being liberally created. Americans who have marked the vigor and the initiation, the skill and the daring displayed by their navy in the recent war, cannot fail to understand where lies the true defense of their coast-line.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

COMBINED MARITIME OPERATIONS.*

By CAPTAIN ASA WALKER, U. S. Navy.

All hostile operations between countries separated by waters, other than rivers, must partake, in a greater or less degree, of the nature of "combined maritime expeditions," and have at their inception, for consideration, the immense problem of convoy.

The subject of convoy is so important and of such scope that in itself it constitutes a broad field for individual labor, and should be treated apart from that of combined operations, since, in truth, but one branch of the service is in position to attack or defend. The military part of a convoy being worse than helpless, all operations must be purely naval.

Leaving, therefore, this subject of convoy to the pen of others, we shall endeavor to discuss briefly the object and scope of combined maritime expeditions, and to demonstrate when and how success may be expected.

Whenever land and naval forces combine in any operations it is to be taken for granted that the component parts will work loyally and well for the accomplishment of the end in view, each within his own sphere of action. The general and the admiral, the officer and the private must sink the individual and look only to the success of the plan given to them to carry to a happy issue.

It is hardly to be presumed, in this day of heavily armed and swift ships, that in a war between two great powers, either would dare to despatch across the water an army of *invasion*, without having previously forwarded a more mobile force to seize and hold a base for its landing. A force of moderate size, to seize, fortify, and hold a place for disembarkment would necessarily be more compact and mobile than one of the same size intended for campaign work, since many serious questions would be eliminated, as this force must be considered, for the time, as being on garrison duty.

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We may, therefore, consider our problem to be how best to seize and hold, with a moderately large combined force, a position on the enemy's coast, at which, when secured, the main expeditionary forces may safely land; or, in other words, to establish a fortified base. That even this primary occupation may be a success presupposes a local superiority in the fleet which must accompany the immense convoy, of which this force is but the advance guard.

While the facilities for maneuvering ships increase from year to year, and the appliances for handling troops grow more and more perfect, yet it is quite impossible to eliminate the element of time from military and naval operations. The arrival of a hostile fleet on a coast, though it be at a point farthest from the centers of population, will be heralded to the whole land before the hulls of the vessels are above the horizon. The nation's forces will thus be told where their enemy is to be found. The hostile fleet must do quick work with its disembarkation and be ready to repulse an active enemy.

The question of command and control in a combined military and naval expedition is one of such vital importance, that upon its disposition depends absolutely the success or failure of the expedition. Educated from their youth up to perform the duties of their profession, on land or on sea, the military and naval officers must be looked upon as experts in their professions. Each must be considered competent in all the duties which may fall to him, in his own sphere. From the very nature of the services, it would seem that a natural boundary line existed, so clear and plain that conflict should be impossible.

As the whole character of a combined expedition is a military one, its conduct, during its various steps, must be under the control of those most experienced in the different stages of its progress. The officers whose lives have been passed on board ship, at sea and in port, would, unquestionably, be better capable of managing the questions of lading, discipline, navigation, and tactics as applied to sea maneuvering, than those of the army branch, whose regular duties are so different. Those who have had to do with military drills, equipments, ordnance supplies, commissary stores, and all the vast multitude of details pertaining to operations of war on shore, should be expected to have entire charge of such matters. From shore to shore should be the sphere of the naval officer, and there his authority should end.

Each transport to carry troops or supplies should be in command of a naval officer, and to him should be intrusted her lading and her discharge; with him should rest the responsibility for her navigation, her proper position in convoy, her efficiency, health, and cleanliness. This is, in effect, the practice in countries, which, in the past, have despatched combined expeditions. The officers of the troops embarked must have complete control over their own men, subject to the general regulations of the ship as to matters of safety, health, and comfort. This naval command afloat is the more essential, as no convoy can expect to cross the seas unattacked, and the commanding officer of each unit therein should be able to maneuver under signal, to avoid confusion in the hour of danger.

That any military expedition may be a success demands the utmost thought and care in the preparation of its details. The character of the troops, their discipline, the proper proportion of the various branches of the army, their supplies of all sorts, and the thousand and one matters, great or small, which militate for the good of the soldier, each and all demand attention. In the case of troops acting in their own territory, such care and forethought is eminently necessary, but its neglect in minor matters would not be so vital, since the possibility of the rectification of mistakes remains. An army with open communications to its base might be expected, in the course of time, to remedy all errors made at its inception. Such is not the case with a combined force; *it* must sail with its outfit complete and work out its own salvation from its condition on leaving port. Hence it is necessary, nay vital, that every energy of those having the outfitting in charge should be strained to the utmost, that all proper equipments should be provided and of ready access to those charged with their stowage and conveyance.

A few hours, or even days, spent in the careful consideration of plans for the stowage of men and material will vastly simplify matters when those men and that material are wanted for service.

Detailed plans of each ship should be made, showing just how many men of any particular branch of the service she can carry, together with all equipments and supplies necessary to make that detachment of troops complete in all respects for service. In other words, if a body of troops be assigned to any ship, that ship should have on board, stowed readily at hand or in proper order, all the outfit, of *every kind*, requisite to the equipment of that unit of force, ready for active service.

Military authorities have investigated the question of the movement of troops and war supplies by transport, and have laid down certain general rules as to the space required for men, horses, and mules. These rules must be more or less flexible, though in general they may be accepted as bases whereby the general plan of an embarkation may be predicated—exceptions may arise with exceptional ships. The rules for space and tonnage given by Captain Goodrich, of our service, are: For men, 52 cubic feet and from 3 to 4 tons; for horses, 126 cubic feet and from 8 to 10 tons.

In making the detail for embarkation, consideration should be had for the character of the troops detailed for each vessel. Ships which would comfortably carry infantry may be entirely unfit to load cavalry, since the latter require a much higher between-decks than the former. In general, vessels for the transportation of horses and mules should have from 10 to 12 feet of headroom for proper stowage.

In the inspection of ships for transport purposes, many points are to be considered other than those pertaining to actual seaworthiness. The comfort and health of the living cargo is of vital importance, and hence every available means must be adopted to have the living quarters clean, dry, and well ventilated. To this end, ventilating fans should be installed, conduits run to all parts of the living space, particularly to those more remote from the hatchways, and ventilators extending well above the upper deck, built. The exhaust system would thus insure a sufficiency of good air, even with the hatches battened down. A full cargo of mules and horses was recently lost, every animal being asphyxiated because of the battening down of the hatches during a typhoon.

The inspecting officer would naturally give his careful attention to each and every item that constitutes the equipment of a well-found ship, and should, when practicable, determine the metacentric height under various conditions of lading. Anchors, chains, sounding gear, charts, nautical instruments, capstans, windlasses, steering gear, and all other devices of navigation should be carefully overhauled and put in perfect order. The engines and boilers must be rigidly tested and proved to be without flaw. Hemp and wire hawsers should be stowed where available at the shortest notice, either for towing or taking in tow. Fire pumps and hose should be tested and proved efficient, and a fire bill made out for the *regular crew*, with provision for assistance from the military passengers. Boats, life rafts, and life-preservers must receive the most careful attention in all their parts, and be made ready for immediate use. Bulkheads should be most rigidly inspected and strengthened, if indicating weakness. All valves should be overhauled and made to work freely and well. If practicable, each ship should be docked, so that the underwater body might receive the same attention as the top sides; especially should all the openings through the bottom be examined for local deterioration. The flushing system of the ship should be put in perfect order, that a copious supply of water may be delivered to the water-closets, of which there should be a liberal number, properly located. The berths for the troops should be arranged so that they may be readily unshipped and removed, to allow a thorough cleaning of the sleeping quarters; the decks of these quarters should be well covered with shellac throughout, to insure dryness.

Accommodations for a fixed number of troops having been made on board a transport, the equipments and supplies complete for them should be tallied with the ship's name, letter, or number, and assembled at her place of lading. The officer in command must receive and stow these articles in such order that all may be, in a degree, available in a brief space of time. Too much stress cannot be laid on the importance of having stowed on board of each transport every article which goes to make up a perfect equipment for the personnel therein contained. Instances are on record where vitally necessary stores have been so stowed as to be unavailable for days. Various parts of gun mounts have been embarked in different ships—wheels in one, axles in another, etc.—so that the utmost confusion resulted when it became necessary to assemble them, and the battery, for the time being, was helpless and useless.

All stores, supplies, and equipments should be received on board and stowed before the troops are admitted to the ship, and this work should be done by the ship's company, or by stevedores under the direction of the ship's officers.

When about to embark the troops, the officers of each company should individually be shown the exact location of their company quarters and the shortest and least obstructed passage thereto, and should be instructed where to form when arriving on board. The racks for arms and equipments should also be designated for each unit of the force.

The question of messing the troops will depend largely on the interior arrangements of the ships, and must be met by each one according to circumstances.

The boats with which a ship is provided are intended for the general service of the ship, and for the rescue of the crew and passengers in case of disaster. They should have sufficient capacity to contain all the people who may be embarked in the ship, together with a moderate amount of provisions and water. When, however, there is a question of disembarking troops, with their proper equipments, in a ship's boats, it is found that but few can be accommodated, save in those of the largest size. No ship's boat is suitable for the transportation of horses or artillery. It has long been the aim of the military authorities to devise some practicable craft for landing troops and supplies, one which could be transported with the troops and put into immediate use on the arrival at the place of disembarkment. Many models have been suggested, many have been tried, yet, thus far, not one has shown itself the perfect article from all points of view. It is not difficult to construct a float, pontoon, or scow which would answer perfectly, but when it is constructed the question will arise how to get it to the scene of operations. If it be stowed on the side of the transport it is liable to be destroyed by the sea, should heavy weather come on; if carried on deck, it occupies too much of the deck space, every inch of which is necessary to the health and comfort of the living freight; towing will be out of the question. Connected with every combined fleet there must be a proportion of vessels exclusively employed as freight boats, in the capacity of colliers and supply ships. To these may be relegated the duty of conveying the scows for landing the troops and munitions. Each collier or supply boat could readily carry on her upper deck, on properly constructed beds, four or more scows of sufficient capacity to lighter troops of all arms of the service, with the requisite supplies. Fitted as they would be with cargo booms, these ships could handle the scows with perfect ease. Each transport should have a steam launch of sufficient power to handle one or more loaded scows in weather, such as would be necessitated for landing. Crews for the scows should be furnished from the personnel of the transports and supply ships.

In the present day, when the civilized nations of the world have made elaborate charts of their own coasts, and have sent forth expeditions to survey and chart the coasts of less civilized peoples, there remains less for the commanding officer of a combined expedition to decide than in remote periods. The hydrography and topography of coasts are so well delineated on charts that an engineer, in his study, can determine almost absolutely at what point or points an expedition would find conditions suitable for a landing, and surroundings capable of occupation as a fortified base. This problem would no longer be left to chance, or to the judgment of the expeditionary commander. While it would be necessary to leave such commander a certain amount of latitude in his operations, his instructions would be such as to confine those operations to places selected by the council in charge of the war. In his instructions would be found complete details of the natural features of the places favorable for securing the object of the attack, together with the consideration of the harbor facilities, sanitary conditions and local supplies.

Considering the power of modern ordnance and the range of the small arms of to-day, it would seem hopeless for a combined expedition to force a landing where strongly opposed. A few well-placed, and well-served heavy guns on shore can withstand successfully many times their number afloat. Fleets cannot silence and destroy forts. Troops cannot land in the face of earthworks and fortifications well manned; landings must, therefore, be made at points where no fortifications, or but slight ones, exist. Infantry opposition to a landing has become a more serious matter than in former days, the increased range of the rifle permitting effective work at much greater distances, demanding a heavier and more extended sweeping by gun-fire of the environs of the proposed point of disembarkment.

As in former times, it is necessary to consider the general outline of the coast for purposes of landing. The concave or deeply indented shore has become far more undesirable and dangerous as the range of arms has increased, and the point or peninsula has lost, to some extent, the strength formerly attached to it, since now a far greater extent of territory must be cleared than in the days of the smoothbore. It is possible that a long, sheltered, and straight beach may present advantages not to be excelled, even when held by the enemy in force. The extreme mobility of a fleet permits it to threaten attack at points widely remote in distance, though comparatively near in time. The great Admiral Blake, in his attack on Jersey, though dependent on the wind, feinted attack at points so distant from each other that the forces of Carteret were completely exhausted in the endeavor to meet them, so that when the real effort was made there was but a feeble force to resist, and Blake's troops were securely established.

In both of the attacks on Louisburg in the last century the same tactics were employed, and in both cases with an eminent degree of success. With such illustrations from the past, when the motive power of the transports was the wind, and that of the boat, wind and human muscle combined, it would seem that the present facilities of locomotion on the water would warrant us in the expectation of being able to deliver attack at will on coasts, however well defended by land forces unintrenched.

In approaching a coast for the purpose of landing, most careful work in reconnaissance must be made. The smaller vessels of the fleet, with proper representations of the general staff of both army and navy on board, should make a thorough examination of the whole littoral, to determine what points, if any, are held in force, what fortifications exist, where the beach presents the most favorable conditions of approach, and make sure that the landing is made under the most favorable circumstances. Here, it would seem, a captive balloon could be used to good effect.

A landing in force on a wooded beach should be made only after a most careful examination from the water, followed by the explorations of scouts landed at several points. These scouts would force the enemy to show himself and unmask his positions. The vessels of light draft should be able to support these, and rescue them if hard pressed.

An unopposed landing presents few difficulties, and should be accomplished by a well-organized expedition in quick time and in perfect order. The headquarters for the various units of the corps should be marked by flags placed in conspicuous positions, and the transports conveying those units, of all arms, should be brought as near the headquarters flags as possible. Companies should fall in at the instant of landing and take their proper places in regimental formation. Regiments should at once proceed to brigade headquarters and assume position assigned. Each officer should clearly understand the part that his body of troops is to perform, and its place in the grand whole. At this time will be recognized the supreme advantage of having placed on board each transport the complete equipments of the force thereon embarked. Each transport will land its living freight, armed cap-a-pie, ready for immediate service.

With the troops once disembarked the landing of supplies becomes a matter of detail, dependent largely on the operations of the force landed. As the intentions of the force were, primarily, to establish a fortified base, these supplies would consist chiefly of material for that purpose, and would not include, to any great extent, the material for transportation, and the vast trains of supplies necessary for long marches in an enemy's country. So long as the army could keep in touch with the fleet, the bulk of the supplies would find ready transport by water. It goes without saying that the first objective of the expedition would be the seizure of some harbor or sound, in which its fleets could anchor and be protected from the weather, and where its forces could entrench themselves and protect the approaches. To this end the landing must be made not far from such harbor or sound. The details of all land operations belong to the military branch of the expedition and must be carried out by it, the assistance of the naval force being given wherever practicable.

When the landing is opposed, the commander-in-chief must be governed by circumstances as to the point of disembarking the troops. He must determine in what positions the enemy is in strongest force and select the least exposed route for his boats and the place at which the forces can most readily establish themselves. In this case it would seem imperative that feints should be made at widely distant points, to confuse and divide the enemy's forces. The entire extent of shore at the place of landing must be kept under the guns of the convoying fleet, the smaller vessels as near to the beach as the water will permit. The rapid-fire batteries of these war vessels should be able to break up any heavy attack on the landing forces.

The intelligence bureaus of all the powers, in recent years, have devoted so much attention to the affairs of their neighbors that the littoral of every foreign country is almost as well known as that of their own land. Each railroad, wagon road, and even footpath is on the war chart; telegraph and telephone lines are delineated; churches, farm houses, and barns are cut in with the utmost care; each hill, woodland, meadow, and swamp is designated in detail. Hence, a general, landing or proposing to land on a hostile coast, would have all necessary material for formulating a plan of immediate campaign; the necessity for extended reconnaissances in an unknown country no longer existing, he could assign his various units of force at once to their stations.

History furnishes but few examples where combined expeditions have been landed when seriously opposed. In most cases the winds and sea—surf—have offered the greatest resistance, and to them may be attributed the main loss. General Abercrombie's landing at Aboukir Bay, in 1801, appears to be the sole combined expedition, in force, given us in modern times, where serious opposition was met with and successfully overcome. This success seems to have been due to overconfidence on the part of the French, who had plenty of time to reinforce their forces and strengthen their works to such an extent as to render the landing impossible. As it was, 2000 men were left to protect 3 miles of beach against the 6000 forming the first landing party. The list of killed and wounded attests the bravery of the defense, as well as the gallantry of the attack.

Admiral Colomb, R. N., in his forcible paper on "Combined Military and Naval Operations," has entered into details with reference to the most important of such operations of modern date, and has clearly shown the sphere of each branch of the service therein. He points out how unfitted either is, alone, for the accomplishment of any permanent conquest. He says: "In every case, the navy was but the handmaid of the army, as far as attack went," and again, "The function of the naval force is to guard the communications over sea and to take care that no interference with the operations of the land forces is offered from the sea."

It would seem to be the general opinion of good authorities on the subject, that when the naval portion of the expedition has convoyed the transports in safety to a landing, has successfully assisted at that landing, has afforded protection to the wing of the army within range of its guns, and has established an efficient blockade, to prevent annoyance from enemy's vessels and the introduction of supplies from the sea, its rôle becomes a passive one, subordinate, in all shore operations, to that of the army.

If, in violation of precedent, a landing be made in the face of strongly posted troops or fortifications, it must be regarded in the light of a forlorn hope. All the chances are against success and attempt is but courting disaster. Modern armaments serve to accentuate this fact, since the range of death-dealing weapons has been so wonderfully increased. The landing of vast bodies of men and horses, with the artillery and stores, even under the most favorable circumstances and with the most perfect organization, presents great difficulties. If, then, we complicate these difficulties by subjecting the troops to the fire of a determined enemy, begun at long range and continued during the confusion attendant on disembarking, what but pre-eminent disaster can be the result? Under no circumstances can the result of a battle be absolutely certain until the fight has been made; yet no general, of his free will, will begin an action unless he believes he has at least an even chance of success.

In the case under consideration, everything is against the attacking force, and entire discomfiture only can be expected. Undoubtedly, the character of the enemy must be considered, though the old maxim, not to despise one's enemy, should be kept in mind. The English had cause to rue the neglect of this principle in the attack on Taku forts in 1859, where so much intrepid heroism was displayed and whence comes the heart-stirring phrase, " Blood is thicker than water."

If, in attempting to land in the face of an enemy, his fire is found too heavy while yet the troops are in the boats, the retreat may be made, possibly in good order, but doubtless with serious loss; but should the troops have been landed before the enemy's strength has developed, then retreat becomes a far more serious matter—the troops must be embarked in the presence of an active enemy. All defense now depends on the fire of the warships, and *its* efficiency upon the nature of the ground. If the ground be flat, then the embarking troops mask the fire of their warships and prevent aid to themselves; if it be high, sloping toward the beach, it may be possible for the ship gun-fire to hold the enemy in check while the embarkation is proceeding. Under the best circumstances, the loss in men and material must be immense. History furnishes few instances, in modern times, where troops have embarked under fire, and these few give warning of its extreme peril.

In closing this most imperfect and brief consideration of an important subject, it seems pertinent to dwell for a moment on the points which appear to be demanded to conduct to a successful issue. It will suffice to name them, as each has been mentioned and treated within. Transports *must* be absolutely under naval control; they must be loaded and discharged by the navy; organization on board must be effected and maintained on a naval basis; the embarkation and disembarkation of troops should be practiced, as a drill, during the period of outfitting; each transport should carry a complete outfit, in every particular, for the troops conveyed by it, and should have its stores so stowed that each class may be available for immediate issue.

In the recent landing of our forces on the coast of Cuba the entire neglect of the above-enunciated principles caused all of the troubles and vexations met with. Had the transports been in charge of naval officers, trained in obedience to the orders of their senior officers, there would have been no seeking for a transport five or more miles at sea; each one would have been in its assigned position. The excellent work done by Captain Goodrich, as the naval officer in charge of landing, reflects the highest honor on him and on the service he ornaments, yet, what might have been the tale of men landed had the organization and control been such as above designated. With the facilities at his command he accomplished wonders; his arrangement of them was practically perfect, but his difficulties were so numerous and unavoidable that the results, though grand, were reduced to a minimum.

It is to be hoped that " experientia docet " will become a truth in any future combined operations in which this country may be engaged, and that our sister branch of the service may join with us in relegating " the shoemaker to his last." It were foolishness for the navy to desire control of operations on shore, and, unquestionably, it is equally unwise for those lacking all marine training to invade the territory of the sea. The field is broad enough for both. Let us, then, unite and let our army brothers say to us, " Land us in position to do our work, protect our sea flank, keep open our communications, convoy our supply fleets, and see that we are furnished with the sinews of war, and we will do the rest."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE ST. LOUIS' CABLE-CUTTING.

By CAPTAIN CASPAR F. GOODRICH, U. S. Navy.

The U. S. S. St. Louis left New York on the 30th of April, 1898, to scout off the island of Guadeloupe in the hope of sighting Cervera's fleet. While engaged in this duty, many conversations were held by her officers as to what the ship might do during the war, which would be useful to the country, and as to the various means by which our own cause could be advanced or the enemy's injured. Some one, I have forgotten now who it was, remarked that Admiral Sampson would greatly appreciate the cutting of the submarine cables leading to Cuba and Porto Rico, adding that a cable ship was now a necessary part of any well-organized fleet.

"Not at all," said Chief Officer Segrave, "there is nothing easier than to pick up and cut a cable."

At this the rest of us exclaimed, "How is it done? Can you do it?"

Mr. Segrave replied: "All you have to do is to lower a stout grapnel to the bottom and to drag it slowly across the location of the cable. If the bottom is sandy and free from rocks you can often catch the cable on the first drive. If, on the other hand, the bottom is foul, you may spend a week and not get it even when you have special appliances for the purpose."

"How do you happen to know so much on the subject?"

"I have spent years laying and repairing cables. I have, myself, laid some of the cables now in the West Indies."

"Could you pick up cables in so large a ship as the St. Louis?"

"Why not? It is only a question of devoting a big and valuable craft to work which might equally well be done by a small steamer."

"Would you like to try for those leading to Porto Rico?"

"Very much indeed."

We ran into Guadeloupe on May 11, and I immediately telegraphed to the Navy Department and to the commander-in-chief: "Unless I receive orders to the contrary, I shall destroy the two telegraph cables to San Juan, Porto Rico, which my first officer has laid [in] shallow, navigable waters." That evening, the ship proceeded to St. Thomas where instructions to join the admiral's flagship at a stated rendezvous off Cape Haytien and at a stated hour were given me. Orders *not* to destroy cables never came to me because they were never sent.

We learned at St. Thomas, in ways which it is not well to divulge, that the cable from San Juan to Jamaica was out of order. To isolate Porto Rico, therefore, it would be necessary to cut the St. Thomas-San Juan line and the alternate lines leading out of Ponce to Jamaica and to St. Thomas. As time permitted, we decided to cut the first of these three lines on our way to the flag.

It is always surprising to find out how hard is the obtaining of any exact information on any given subject. We have all had this experience. Generalizations abound, but when one wants accurate knowledge every topic is seen to bristle with difficulties and to be shrouded in mystery. Cable-cutting is no exception to the rule. Now there are two important conditions essential to success in this operation. In the first place, you must know where the cable lies; and, in the second, how to pick it up. I think it may be broadly stated that, outside of the records of the proprietary cable company and excepting as to some shore ends, the precise location of every cable is unknown. No chart that I was able to obtain, no source of intelligence, could tell me the very spot to go to for the purpose of raising the submarine wires I wished to sever. True, there are many charts indicating the presence of such lines connecting various ports, but they are all schematic only. To follow such a diagram closely in the belief that it will lead to the particular point sought would be a waste of time. There is one consideration, however, which is always useful as a guide. Cables are costly. Even the deep sea portions, which are lighter than the shore ends, are expensive, the price running from $500 per mile upwards. It may therefore be confidently assumed that where the water is over 20 fathoms in depth and consequently quite undisturbed by heavy gales of wind, the company will follow the shortest distance between the terminal points, which, in sweeping around an irregular and salient shore, will pass, naturally, from headland to headland. For example, when wishing to pick up the Santiago-Jamaica cables, we drew on the chart the straight course connecting the harbor mouth with Holland Bay, Jamaica, where the cables land, and we were confident that what we sought would be found, if at all, not far away. As a matter of fact we got the cables just where we reasoned that they must lie. But how much more satisfactory it is to know in advance where the cable was originally placed, and how fortunate I was to have at my disposal a man who had placed it there himself and knew how to go about grappling for it.

The process of grappling is very simple in the abstract. Over the *bow*, you lower a grapnel to the bottom and then steam very slowly ahead—barely moving the ship—square across the line of the cable. The grapnel creeps over the bottom, its prongs burrowing slightly under the surface of the soil until they catch underneath the cable. The gradually increasing tension on the grappling rope reveals to the expert, whose hand is always on the outboard part, that the cable is caught. The movements of the ship are under his control by signals to the bridge, and he measures the speed by the old device of the Dutchman's log—billets of wood thrown overboard from time to time. It is well to keep going ahead for a few minutes after getting an unmistakable "bite" in order to lift the cable off the bottom and thus ensure its being well hooked. Then the ship is stopped, the line taken to a steam capstan or winch and hove in. As soon as the bight is well out of water a hawser is bent to it and the grapnel relieved of its duty. When the cable is inboard a stout plank to protect the deck, a couple of sharp blows with an axe and the thing is done. Letting one end go and steaming a couple of miles away with the other make a gap of sufficient magnitude to embarrass the repair steamer, should she come along before peace is declared.

Practically much depends on the judgment and experience of the operator. He knows when it is best to put a shot of ¾-inch chain just ahead of the grapnel; when best to use manila; when ordinary wire is advisable. For deep sea work, in 1200 fathoms or upwards, a special steel rope has been developed, very strong, very light, very flexible, its outer strands wrapped with hemp yarns. The "feel" is so much deadened that with improvised appliances you might catch and part a cable in such a depth of water and be never the wiser; or, you might miss it and think you had broken it. It is the old story—sooner or later in any particular branch of human activity we must abandon makeshifts, use standard appliances and call in the professional.

The conditions I have just described are those most commonly found—a comparatively smooth sandy or gravelly floor. For such conditions the outfit mentioned will suffice, with patience and care.

But cables often lie on rocky bottoms; possibly they run between boulders or coral heads that protect them from the searching prong of the grapnel which engages under one rock only to spring, when freed, clean and clear over the modest and retiring wire, or to have its prongs straightened out to a state of flabby uselessness. Here a cable is as safe as if buried in a trench except for the one chance out of the thousand which favors the grappler. Under these circumstances, recourse is had to one or more so-called centipedes. Imagine a piece of five- or six-inch lap-welded iron pipe, about three or four feet long. A series of square holes is cut in this pipe, each pair at opposite ends of a diameter, the diameters being placed spirally along the length of the pipe. Through each hole and its opposite, square pieces of iron or steel are driven and the ends turned forwards towards the ring by which the instrument is towed. This is a centipede. It always has for its leader a length of chain. Two or more centipedes with their leaders are occasionally bent tandem to the same line. Perseverance and repeated trials are necessary even when centipedes abound. In cable practice it is sometimes considered economical to abandon altogether a leaky wire and to replace it with a new one rather than attempt to raise and repair it in such foul bottom.

While on this branch of the subject I may remark that the two cables from Santiago to Cienfuegos come under the head of cables protected by the nature of the bottom. We made altogether in the St. Louis and Suwanee no less than fourteen drives for them at points varying from just outside the harbor mouth at Santiago to ten miles distant but we never succeeded in getting the wire or in bringing up anything more than the grapnel itself with its prongs straightened out like the ribs of an inverted umbrella. The Santiago-Cienfuegos cables were our conspicuous failure.

On the 13th of May the St. Louis broke the San Juan-St. Thomas cable. It was necessary to go quite close to the beach about eight miles east of San Juan—and great was the excitement created on shore by our approach. Horsemen could be seen riding frantically in all directions, doubtless to summon troops to resist or friends to facilitate an assumed landing on our part. Not being able to determine which was the actuating sentiment, friendship or enmity, we refrained from firing. The grapnel opened out in this drive, but it brought up enough of the gutta percha insulation and of the protecting hemp to justify us in believing that the cable was actually parted, corroborating the evidence of the heavy strain and sudden release of tension.

When, next morning early, I reported to Admiral Sampson, on board his flagship, both what I had done and what I thought I could do, he expressed his great satisfaction and he quickly adopted my suggestion that the St. Louis continue the work she had begun. Chief Officer Segrave was summoned over from the St. Louis that he might explain to the admiral his requirements in the matter of lines and grapnels. A number of Manila hawsers of 6, 7 and 8 in. circumference, and a lot of stout grapnels were delivered to us by the fleet. For inshore work, where light draught and handiness were necessary, the admiral was good enough to assign to my assistance the U. S. S. Wompatuck, commanded by an excellent, faithful and brave officer, Lieutenant Carl W. Jungen, U. S. Navy.

When such preparations were completed as the resources of the fleet permitted the St. Louis, displacing over 17,000 tons, the largest vessel, by the way, which ever wore a pennant, and her little consort, the Wompatuck, of 462 tons displacement, steamed away from the flag towards Santiago de Cuba, our first point of attack on the enemy's submarine communications with Cuba.

The following day, the 15th of May, was spent in the Windward Passage out of sight of land in fitting up the Wompatuck for grappling, furnishing her with steaming water, etc. It was determined that an attempt on the Santiago-Jamaica cables should be made by that vessel May 16, and we timed our movements so as to arrive off the port about 9 P. M.

The night was appropriate to the work, being moonless, but clouds with mist and rain would have been still more acceptable as obscuring us from the enemy. Such as the weather was, however, the stars shining brilliantly in the calm air, we had no choice but to go in and run the risk of detection. Accordingly, a volunteer party from the St. Louis, with Chief Officer Segrave at its head, went on board the Wompatuck with me. They were not, as yet, formally enlisted or commissioned in the United States Navy, were in fact only under charter to the government by the American Line and thus lay under no positive obligation to endanger their lives in a military enterprise.

The Wompatuck approached the port from the westward, hugging the land and stealing slowly towards the Morro which soon towered above her. We were at the very mouth of the harbor. Lowering the grapnel quietly we soon had hold of a telegraph cable and then the heaving-in process began. In spite of our precautions, some noise must have been made, for a patrol boat came out towards us. Supposing that the Morro, which was close to us, mounted guns, and believing that our presence, now known, would bring a reinforcement sufficient to deprive us of the four or five hours necessary to grapple, raise and cut both Jamaica cables, I decided to abandon the attempt that night and try to reach my end in another way. We returned to the St. Louis, which lay in the offing, and learned that during our absence she had been chased by two patrol vessels flashing signals to each other. We then steamed well out of sight to the southward and westward.

On the 18th of May the St. Louis and Wompatuck came from the westward towards Santiago at daylight at the distance of a mile or so from the beach. At 5 A. M. we were within range of the batteries. The Morro fired a gun to give warning of our approach, and we supposed that it would be followed by a general opening of fire upon us. In this we were agreeably disappointed.

The water is so deep off Santiago that it was necessary to pass quite close to the batteries in order to reach bottom with our grapnel. When on a predetermined line of bearing from the lighthouse we lowered down not far from a thousand fathoms of hawser and began the slow work of feeling for the cable. It was not until after 11 A. M., if my memory serves me rightly, that the St. Louis hooked her fish and could heave in. In the meantime, great activity and excitement prevailed on shore.

Steamboats plied between the Morro and the city bringing troops and carrying away passengers whom we took to be women and children. At the Socapa battery and at that to the eastward of the Morro, men were working like beavers to get guns into position. It was evident that the Krupp 6-in. B. L. R.'s we had been told of as in place were not ready. Still no effort was made to disturb us, and I doubt whether, for a long time, the Spaniards suspected our object. At about noon, however, we had begun to lift the cable. Word to that effect must have been sent to the officer in command from the cable station, for the Spaniards opened on the ship—the lighthouse being then distant a mile and a tenth by observation. The shots were not well directed, however. We had no difficulty in shortly driving the gunners from their pieces near the Morro, or in seeing them as they ran away.* The Wompatuck, which had been lying well outside of the St. Louis, came up in great shape and joined in the action. The total broadside of the American ships in this fight was two 6-pounders on board the St. Louis and one 3-pounder on board the Wompatuck.

The battery of rifled mortars on Punta Gorda gave me much concern, for it was entirely out of reach of my little guns and yet was able to drop its shells all around us. We were practically a stationary target, for the St. Louis was fast to the cable. We could not make up our minds to let that go, so we stuck to it and hove it up. Once the bight was secured we could steam away as we liked. It was a great relief to me when the valuable and most vulnerable ship I commanded had put the western point of land between her and Punta Gorda. We were some forty odd minutes under fire—and exposed to large shells sent from guns beyond our range, whose accuracy of aim became painfully threatening. However, "all's well that ends well." We got the cable; we fought the Spaniards; and we silenced the guns that were within our range; and we escaped unhurt.

The next day we made an unsuccessful attempt to cut the French cable at Guantanamo, which we cut the day following, outside the Mole St. Nicholas. At this point the Wompatuck left us to join the flag at Key West.

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*In the table of bombardments of Santiago given by Commander J——, Proceedings Naval Institute, March, 1899, p. 29, it is stated that a 16-cm. gun at the Morro "could only fire three shots." It appeared to us on board the St. Louis as if the cause lay rather with the gun's crew, which certainly, to a man, sprinted in fine form.

The rough coral bottom off the south side of Porto Rico frustrated our subsequent efforts to isolate that island and demonstrated the need of special tools.

I have spoken already of my repeated failures to get the Santiago-Cienfuegos cable by which Havana communicated with Santiago. On two of these occasions we got at night close into the beach under the Socapa battery, once in the St. Louis, when there were but 12 fathoms of water under her bow, which lay just outside of the surf. Why the Spaniards did not blow the big liner out of water surpasses my comprehension. She offered an ideal target, her huge bulk plainly outlined as a silhouette against the background of a search-light beam behind her. Again, in the Suwanee, on June 16th, I got even closer still —so close that Lieut. Aranco of the Spanish Navy vainly begged the gunners to open fire on us, for he could both see and hear us distinctly. Probably Lt.-Comdr. Delehanty, who commanded the Suwanee, would have rejoiced in being fired at. For myself, I frankly confess I am glad the Spanish commandant rejected Aranco's proposition.

About this time the Army Signal Corps was vainly endeavoring to get the remaining Santiago-Jamaica cable—the one which it seems the St. Louis had left intact on May 18, although I had reason at the time to believe it broken. The corps had chartered the cable steamer Adria, fully equipped for such work, while I had furnished all the information in my possession, had described how and where I had grappled number one, and what measures I should take to secure number two. As far as I could I aided in every way. Among other things I had strongly advised steaming across the line of the cable from east to west, for I had towed the broken ends of number one to the westward, leaving the eastern approach clear. Any cable picked up to the eastward would, therefore, in all probability, be a live cable.

Provided thus with all the counsel and knowledge at my disposal, the cable steamer, under the Signal Corps, made one last and dramatic effort—passing over the line with the Oregon and Texas between her and the batteries. To make a long story short she went from *west* to *east* and she did not get the cable then or at any other time.

On the night of June 18, the admiral allowed the St. Louis to try for the remaining cable. Starting in after nightfall and proceeding from *east* to *west* she picked up and severed the cable without difficulty or loss of time. From that date on no telegraphic messages passed out of Cuba via Santiago.*

The St. Louis cut the French cable from Guantanamo to Santiago on June 7, and the same day she grappled that from Guantanamo to Mole St. Nicholas. By the admiral's orders the latter was not cut, but about ten inches of the conductor were removed, and the injured place buoyed. The idea was to have this line only temporarily disabled and ready for subsequent use with but slight repairs. It is an interesting fact that for several hours afterwards, messages were sent and received over the damaged line. The moral is that if you want to stop the enemy's use of a cable you must completely sever it and separate the ends.

It was Chief Officer Segrave who put us in the way of cutting cables and who actually cut three, viz., San Juan-St. Thomas, the first Santiago-Jamaica, and the Guantanamo-Mole St. Nicholas lines. It was his temporary successor, Chief Officer Geo. E. Beckwith, who cut the two cables which formed the loop on the Santiago-Hayti section, leading into and out of Guantanamo—a most difficult job it was, too—and also the last Santiago-Jamaica link. They both bore commissions in the navy of the United States and well had they deserved them.

The St. Louis thus cut *every* foreign cable leading to Cuba and established an honorable name in connection with work which could hardly have been in the minds of her designers when they drew the plans of so noble a vessel, distinguished in war as well as peace.

It would be unfair if I brought this brief sketch of events to a close without recording my appreciation of the loyalty and pluck of Commander Randle, previously and subsequently the worthy commodore of the American Line, who was the sailing master of the St. Louis during the war when not actually in command of her, and my indebtedness to his zealous and never-failing co-operation. In all this he was imitated by the officers and men who served directly under him, and who speedily set up a healthy rivalry in all good things with "the regulars" on board composed of my aid, Ensign F. R. Payne, Lieut. A. W. Catlin, U. S. M. C., and his excellent guard of marines, not to mention four naval cadets of the third class at the Naval Academy, Messrs. Fremont, Williams, Cook and Goodrich.

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* Marine Barracks, Navy Yard, Brooklyn, N. Y.,
November 15, 1898.

I certify that on August 10, 1898, I landed at the cable station at the entrance to Santiago Harbor, and had a conversation with the operator. During the conversation the operator informed me that no news had been received or sent over the Jamaica-Santiago cable since the 18th of June, the night when the St. Louis cut the last cable in front of Santiago.

A. W. CATLIN,
First Lieutenant, U. S. M. C.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

TACTICAL CONSIDERATIONS INVOLVED IN THE DESIGN OF THE TORPEDO-BOAT.*

By Lieut. A. P. Niblack, U. S. N.

Up to a very recent period there were a few large firms in Europe which had practically a monopoly in torpedo-boat construction, and which, in a measure, set the fashions and ordained the types. To-day, however, both in Europe and the United States, almost any shipyard or marine engineering firm, without traditions or previous experience, seems willing to take contracts either on plans or designs of its own or on those furnished by the governments interested. Owing to this breaking away from old traditions and to the enormous advances made in naval construction and marine engineering, we find a resultant uncertainty as to just what is the best type of torpedo-boat. The best means of approaching the question would seem logically to be through a study of its weapon, the torpedo, regarded as the only excuse for the existence of the boat.

An automobile torpedo, launched over water from a rapidly moving and oscillating platform, encounters many variable impulses tending to deflect it from its normal course. The wrong angle of incidence of the torpedo in striking the water may give too deep or too shoal an initial dive, or deflect the torpedo laterally. Moreover, each torpedo has its nice adjustments and peculiarities, which must be learned by trial runs, so that, in general, it may be stated that much practice must be had with a given boat and with each individual torpedo to insure the chances of hitting, when the torpedo-boat has survived the many perils which beset it in getting within striking distance.

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* Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.

It may be stated, roughly, that the highest development of the present type of torpedo is one about 16 feet long, 18 inches in diameter, and carrying a charge equivalent to 110 pounds dry guncotton. The highest pressure used in the air-flasks to operate the engines is 1500 pounds per square inch, giving a speed of from 30 to 32 knots at 400 yards, 28 to 30 knots for 800 yards, and 26 knots for 1000 yards. There are, of course, innumerable sizes, shapes and variations. Some carry twice the above weight of charge. Distance and speed are largely matters of pressure and size of air-flask. Some unusually long ones, for coast defense, run as high as 30 knots for 1000 yards and 24 knots for 2000, but, for torpedo-boats, the above length of 16 feet and diameter of 18 inches is about the limit for convenient handling, and for weights of mounts and accessories, as the weights increase unduly for small increments in dimensions.

The torpedo is not a delicate instrument, and, after seeing many trials under varying conditions, one comes to feel that it is almost animate; but, for all that, there is a popular mistrust of its ultimate value as a weapon, in spite of what its advocates claim for it; and yet, curiously enough, the world is not yet alive to the fact that a complete revolution has taken place in the status of the torpedo by recent inventions and improvements. It now has a secure and permanent place in naval warfare, and it only remains to accept the fact.

The first improvement is the application of the principle of the gyroscope to the steering rudders of the torpedo, and the second is the perfection of apparatus that will safely and accurately launch torpedoes from the under-water broadside of a rapidly moving ship. The latter practically does away with above-water discharge in large ships, and the former has doubled the accuracy of fire.

In the Howell torpedo, the invention of Rear Admiral J. A. Howell, U. S. N., the motive power is a fly-wheel spun up previous to launching, and the remarkable results in directive force and persistence of the torpedo by the gyroscopic action of the fly-wheel has led to its adoption in a miniature form as a separate attachment to an ordinary torpedo, involving no radical changes in design, since it takes the place of a certain amount of ballast and merely adds a pair of rudders and a few connections. The first practical design of this was by an Austrian, named Obry, and Whitehead & Company acquired the sole rights. The question of infringement of the Howell patents has not deterred others, and there is a successful one in Germany.

We had a naval commission at Fiume in November, 1896, to witness the first exhibition of the workings of the Obry attachment, and, later, a trial in the United States, which showed that it was "an excellent practical apparatus sufficiently robust for the conditions of use, not difficult of adjustment, and not requiring frequent adjustment, and its capacity for steering the torpedo in the course indicated by the direction of the axis of the torpedo at the moment of launching or in a course parallel thereto, after the first unavoidable deflections due to unfavorable conditions of launching, was such as to improve the performance of the torpedo 100 per cent."

Our naval commission at Fiume made the following trials successfully, not once, but many times: Ordinarily the gear does not start up until the moment of launching of the torpedo, which act puts in operation a tightly-wound clock spring, which, in turn, spins up the gyroscope and keeps it going. A torpedo-boat, at high speed, steaming past a target at some 600 yards distance, pointed its tube at the target, and, by a special arrangement, released the spring. The tube was then turned off the target about 45 degrees, and the torpedo launched. The gyroscope, true to its principle, brought the torpedo back *parallel* to the original plane in which it was started in operation, and excellent targets were made. The course of the torpedo thus fired is a horizontal curve.

At Fiume, using the attachment, excellent results are obtained from fixed under-water launching at 1000 yards, and, with improvements in air-flasks as to volume and pressure, we may expect to see the effective range of torpedoes in naval warfare regarded as 800 yards, instead of being limited, as now, to 500 yards or less. Torpedoes, which are erratic, ordinarily, to the point of rejection, are fired successfully right along, using the Obry gear, and, in a recent trial, torpedoes were fired from an under-water broadside tube of a ship steaming 16 knots, and made excellent targets, using the attachment, although the permanent angle of deflection of the torpedo, due to the method of launching, was not known within 10 degrees. As the Obry gear and the method of under-water discharge from ships have both been adopted in our navy, we may assume that in the future we may count tactically on these latest inventions being used, at least in large ships.

If we consider the conditions under which a torpedo-boat may be reasonably expected to be effective against a ship or the ships of the enemy, we will find that an attack, to have a reasonable chance, must be a surprise. Hence darkness, fog, mist, snow, and rain are the favoring conditions. Heavy rains are particularly favorable since, for the defense, the eyes of lookouts are punished severely by the water, it is hard to keep men constantly at the battery, the searchlight is worse than useless, sights are blurred, and outside noise is deadened by the fall of rain. Attacks are made in groups of boats, and it is this which we lose sight of in the United States. A single boat would only attack as a forlorn hope, and under most extraordinary circumstances. All torpedo-boat attack must be in groups, and must be, as in polo or football, or any other similar game, a question of "team work," of "interference," of strategy, head, and nerve. Of all things, it is a question of system. A ship or a squadron attacked simultaneously from various directions must destroy or drive off all the attacking boats or take the consequences. Feints will naturally be made. The first boat or boats discovered will advance fearlessly, dropping and scattering small incandescent buoys to disconcert the aim and create the illusion of numbers, and, if so fitted, use their searchlight. Under strong excitement it is peculiarly human to yield to the temptation of shooting at a light without reasoning. Meanwhile, some one or more boats will get in their torpedoes from an unexpected quarter. Numerous tests at manœuvres in many navies have shown that it is astounding how often torpedo-boats get in *without being seen* and when *expected*. Some people go so far as to say that the searchlight beam is the safest path of approach, and, in one navy, they practice running in it so as to get accustomed to the glare and to judge distances.

In approaching to the attack, previous to discovery, reduced speed must be used so as to avoid white bow waves, smoke and flame, and that peculiar and far-sounding hum which accompanies fast-running machinery. Once discovered, or once within striking distance, high speed becomes important, but it takes some little time to attain it after having once slowed. As between a speed of 20 and one of 30 knots, the time it takes to cover 1000 yards is only as 90 seconds to 60 seconds. Can the 30-knot boat pass from 20 to 30 knots in 30 seconds? If you can build three boats of 22 knots for what two of 30 knots cost, and if the greater the number of attacking boats the better the chances, is it not wise to forego phenomenal speed? This craze for great speed is illogical and tactically it is indefensible. Back of it is generally an advertisement for somebody. People who handle torpedo-boats have never sanctioned it. What they do ask is that boats be built in groups on identical designs, and that every reasonable effort be made to standardize fittings. As long as fittings are standardized, we may improve groups progressively from year to year as experience dictates.

We are boxing the compass in our torpedo-boat building programme, and there seems to be no known relation between horse-power and displacement. The real excuse for the boats is that they shall carry torpedoes. Let us look abroad and learn lessons. To say that we have not yet had experience enough to warrant us in standardizing fittings is begging the question. From a military standpoint the standardizing is more important than that the fittings should be the latest complicated invention, largely experimental. It is a simple matter to decide, for instance, that all boats shall have the same size and type of water-tight doors, hatches, conning towers, hatch-covers, manholes, bunker-plates, anchors, cables, winches, steering engines, annunciators, telltales, galleys, deck-chests, navigation supplies, fenders, reels, compasses, torpedo-cranes, awnings, whistles, sirens, bunks, mess-tables, etc. This would do to start with, but the logical culmination of the idea is to build the boats in groups with interchangeable parts.

Before taking up the question of the proper relation between tonnage and horse-power for first-class torpedo-boats, let us look at some of the questions of detail, as illustrated by foreign practice. We regard it as essential, apparently, that a torpedo-boat of considerable size shall have twin screws. Great Britain has nearly 100 first-class torpedo-boats, varying in tonnage up to 130 tons, and of which only one has twin screws. Austria has 30 of from 78 to 134 tons, all single screw. In Italy twin screws are used above 100 tons displacement, and single screws for boats of less tonnage. In France, with some 225 or more torpedo-boats of from 75 to 150 tons displacement, all have twin screws; but, below 75 tons, single. In Russia, of the first-class boats of from 75 to 140 tons, only one group of seven has twin screws, although there are several other groups building in which this is also true. The vast majority are, however, single screw. In the Baltic countries, Germany, Denmark, Norway and Sweden, practically all boats are single screw and have bow torpedo-tubes. Nearly all the boats built by Schichau, of Elbing, Germany, are single screw, and this firm has built about half of the torpedo-boats of the world, but these boats have a bow rudder which may be raised or lowered at will, and which, when in operation, increases the manœuvring power very much. This device is equally important in many of our twin-screw boats, since the pivot, in turning, is almost at the fore foot, and turning is best accomplished by throwing the stern about with the screws. A bow rudder would shift the pivot to about midships, and improve the manœuvring power considerably.

As to bow torpedo-tubes, we regard them as a folly, yet most of the boats of the world have them, and there is not, in Germany, a fighting vessel of any type, built or building, which does not have a bow tube either above or below the snout of the ram, below being the accepted position now.

As to the argument as regards single *vs.* twin screws, the former with bow rudders handle quite as well as the latter without, and it is claimed for the single screw that: (1) There is a great saving in oil with only one engine, and, when we consider that with two it takes about twenty-five gallons a day, this is important. (2) It takes fewer men to look out for one engine, the saving being at least two or three. (3) There are fewer moving parts, and, therefore, less chance of breakdown, while, at the same time, sufficient horse-power can be developed to give reasonable speed. (4) The weight and space of machinery is less, and greater strength can be afforded. After all, reliability of machinery is a matter of design, of material, and of high-class workmanship, and single screws have quite as much to commend them as twin, provided sufficient horse-power can be developed. One of the great drawbacks to single screws is that their draft of water is greater, especially for boats with a skeg, or keel support for the heel of rudder, although in some of the Thornycroft and Yarrow boats there are no supports for the rudder, and thus some inches of draft are saved.

As torpedo-boats abroad are frankly intended to manœuvre or cruise in groups, questions of spare parts, breakdowns, shortage in supplies, etc., are not so serious, since the boats rely on one another somewhat in cases of emergency. Probably no country has developed her torpedo-boat system so thoroughly as Germany. Fully 90 per cent of her boats were built by Schichau, and the custom is to order them in groups of eight, all practically of similar design and with interchangeable parts. The tonnage has gradually increased from 85 to 140 tons, as at present. Six of these boats form a group for manœuvring purposes, so that two of the eight are kept in reserve to take the place of any that may come to grief. There are ten large division, or " D " boats, of from 250 to 380 tons displacement, and from 1800 to 5500 horse-power. They are each a sort of flagship, or " mother " boat, for each group of smaller ones, and accompany it everywhere. This division, or " D " boat, carries the heavier spare parts for the six accompanying boats, such as cylinder-heads, piston-rods, propellers, and a reserve supply of stores and fittings. Each " division " has its headquarters at a certain navy yard and has a group of small storehouses at the water front, one for each boat, including the " D " boat and the two in reserve. When a whole division is in the second reserve all the stores of each boat are in its own storehouse, and the group of boats is tied up near the group of storehouses. Any deficiencies in stores or fittings are made up from the large central torpedo storehouse, where all articles are standardized. In the winter the boats in reserve are kept at a uniform temperature by means of steam coils, connected with the shore by piping. Only when repairs are needed are boats hauled out, so that the division may always be ready to be put into commission for trials in 24 hours and ready for war in 48 hours. If in drills, or cruising, a boat is injured, it is astonishing to see how quickly a spare boat of the group is forthcoming, and ready with the crew of the injured boat. Boats in the second reserve are looked out for by the navy-yard force, and a vessel under repair is always in the second reserve.

As to boilers, the locomotive type has at last disappeared in newer boats. It retained its hold as long as it did through its adaptability for burning liquid fuel. The introduction of water-tube boilers has rendered it necessary to experiment somewhat as to the types best suited for burning petroleum refuse. In

Germany they use, very largely, a German product called earth oil, unfitted for refinement, and they burn it on the Italian system (cuneberti), but principally as an auxiliary fuel for high speeds and for starting fires quickly. The Russian refuse oil is used in Italy, and it is stored in tanks at the principal dock-yards, there being on hand a large reserve for war. Practically, all of their torpedo-boats and fully thirty of their largest men-of-war use liquid fuel either entirely or as auxiliary to coal. In Russia experimenting goes on apace. Our country, of all others, might well adopt liquid fuel, although the purity of the ordinary petroleum and lack of residue makes it necessary to conduct experiments. Its evaporative efficiency as compared with coal is as 2.27 to 1. For the same storage capacity it adds 60 per cent to the radius of action of a boat; it can be delivered at sea from tank steamers in a few hours and in bad weather; it is absolutely free from danger of explosion and ignition, which coal is not; the amount used can be regulated accurately; forced draft does not require extra work on the part of any one; there is no need to transport fuel long distances as with coal; it prevents rust in bunkers; if a bunker is pierced the petroleum flows out only to the level of the water; it maintains steam more economically at anchor and in running slowly; the boiler does not choke; there are no ashes to hoist; it is easier on the boilers; it does away with coal-passers; a water-tender can also fire; and above all, it enables us to get steam quicker and to vary the pressure more easily at will. There is one thing to be considered, and that is that the compressed-air method of feeding commends itself in preference to the steam jet, because in the first place the air-compressing machinery must be in every boat anyway, and in the second place, the radius of action of a torpedo-boat is absolutely limited by her fresh-water supply, and not so much, as supposed, by fuel, although, of course, it takes fuel to distill water. It is in this question of fresh-water tanks and storage capacity that all these fancy yachts and phenomenal torpedo-boats prove failures for hard sea service.

One of the most important questions to be asked about a torpedo-boat outside of the motive power is as to the capacity of her distillers and tanks. Moderate, reliable sea speed coupled with large capacity for carrying and distilling fresh water is the fundamental requirement. Distilling ships to accompany ships operating from a distant base are a modern naval necessity. Fresh water represents time and coal, and is not so readily obtained as coal, at least as a commercial article. With liquid fuel, a navy will have to provide itself with tank steamers for both fuel and water, more especially if the method of burning it is by the use of steam spray or jet, but even using the compressed air spray the amount of water required to make up feed-water is astonishing.

All this suggests the question, "What are the desirable characteristics of a first-class sea-going torpedo-boat?" The answer here given is: (1) It should be as small as is consistent with seaworthiness, so as to offer as small a target and be as little visible as possible, and, at the same time, should offer a reasonable stable platform for its torpedo-tubes. (2) It should be designed to have as small a bow wave as possible; its machinery should be as nearly noiseless as practicable; and it should not show flames or smoke from the stacks. (3) It should have a large fresh-water tank capacity and be fitted with two smaller evaporators and distillers in preference to one larger one. (4) It should have a reasonable bunker capacity. If for coal, the design should have in view the future use of liquid fuel. (5) The efficiency of the boat depending so largely upon the physical condition of the crew, habitability should receive due consideration in the design. (6) Speed is not essential, although desirable, but a moderate reliable sea speed, obtained without forcing and without noise, flame and vibration should be striven for.

The use of liquid fuel best avoids the question of flames and smoke from the stack, and noisy machinery and bow waves are best avoided by moderate speed secured by reliable machinery and boilers of ample power normally. A speed of 22-23 knots on a maximum displacement of 110 tons is here suggested for sea-going torpedo-boats, and 45 tons for harbor-defense boats, or boats of the second class. We have in the Morris and the Talbot, built by the Herreshoffs, a near approach to the ideal boats of the first and second class. Boats above 110 tons are too large to go through the systems of canals in the interior waterway which connects New York with South Carolina. On the Pacific Coast, except about Puget Sound, all of the harbors are practically bar-bound in bad weather, and first-class torpedo-boats will not prove as desirable as second-class ones, which are intended only for local harbor defense. Since the coast is so remote from any possible enemy, even a torpedo-boat is a luxury, although a number of sea-going torpedo-boats and destroyers will be required on the Pacific Coast for drill and training purposes, and in Puget Sound for service.

FIRST-CLASS SEA-GOING TORPEDO-BOATS OF SEVERAL NAVIES.

Country.	Date.	Where or by whom built.	Length (ft.).	Beam (ft.).	Draught (ft.).	Displacement (tons).	I. H. P.	Number Screws.	Extreme speed (knots).	Complement.	Coal (tons).
Austria	'95	Yarrow	147.5	14.7	6	107	2200	1	24	26	30
Denmark	'93	Copenhagen	140	14.3	7	114	1300	1	22	24	25
France	'92	Gruville	147.5	14.5	5	114	1550	2	24	34	20
Germany	'92	Schichau	144.4	16.5	7	110	1500	1	24	24	30
Great Britain	'87	Yarrow	135	14	6	105	1540	1	23	21	30
Italy	'97	Italy	135	14	5.3	110	1600	2	25	20	30
Russia	'91	Russia	128	15.7	6.9	98	1250	1	21	13	17
United States	'96	Herreshoff	139	15	4.1	103	1750	2	22.5	26	28
Approximate average	'93		140	14.8	6.0	108	1560	1.4	23.2	23	24

The foregoing table shows the principal characteristics of a certain number of sea-going torpedo-boats of several countries, selected to correspond to a displacement of about 100 tons, but not as representing the standard type, although it may reasonably be assumed that any given boat represents the best at a given date of building. The "approximate average" is, of course, somewhat misleading, but is suggestive. As regards twin *vs.* single screws, it does not prove much. Both the draft and speed of the Morris are greater than given officially, although draft up to a certain point is a matter of little importance, since it is unsafe to fire a torpedo in less than 30 feet of water, owing to the possible initial dive. For canals, 6 feet is not too much. It is estimated that for a boat of about 110 tons displacement it will require about 1550 horse-power to drive her 23 knots, and 3100 horse-power for 30 knots; in other words, about twice as much. Of course a great deal depends upon the design of the boat.

Since 1893 the size of torpedo-boats has increased very considerably, as in France, where the latest type is 150 tons and 4200 horse-power, with 30 knots speed; Germany, 140 tons displacement, 2500 horse-power, and 25 knots; and Italy, 150 tons, 2700 horse-power, and 25 knots.

Just before the war with Spain, the United States bought at Schichau's, Elbing, torpedo-boat No. 450, now called the Somers. She is a single-screw boat of 143 tons displacement, 1700 horse-power, and a speed of 23 knots, and was built, in 1893, on the same lines as a group of other boats for the German navy, but with a quadruple-expansion instead of a triple-expansion engine. As there was no advantage demonstrated in the departure from the standard triple-expansion type, the German government declined to purchase her, and she was later offered to us. I personally recommended her purchase on the ground that whether or not she could be gotten across in time to be of service in case of war, she was a model boat, in many respects, since she was fitted with all the articles so carefully and systematically standardized through all these years by the German navy, and there is not a detail in her that has not its lesson for us. Far from being a failure, as many believe who talk and never think, I personally conducted her trials, which were satisfactory, and would consider it an honor to command her.

In the torpedo-boat discussion last year the following remarks were made [Transactions, Vol. VI, p. 66] which so nearly represent the exact opposite of what is here advocated that they are worth quoting: "I believe we are very far from the final results under the extreme speeds, and as to advocating a slower boat than our enemy has—why, it will undoubtedly place us in a hazardous position. . . . I believe there is plenty of ability in the country to develop men who can handle the more refined type of torpedo-boats, and I believe that it should be invited and should not be condemned any more than the use of the chronometer should. Without careful treatment it is certainly useless, and the torpedo-boat is undoubtedly recognized as being a refined machine." There is a good deal of misconception in all this. A fleet operating on an enemy's coast has with it torpedo-boat destroyers. Their base is the fleet; their purpose, to hunt out and destroy the torpedo-boats of the enemy. To say that it is hazardous to have slower torpedo-boats than one's enemy is to imply that torpedo-boats attack torpedo-boats. The technical opinion is that torpedo-boats operate from a port as a base. If two hostile ports are adjacent, then it might mean something. Of course, a destroyer can overtake a torpedo-boat, or is designed to do so. In a heavy sea an 18-knot cruiser might overtake a 30-knot destroyer. As regards a torpedo-boat being a "refined machine," every effort should be made to get it out of that category. Of course, a torpedo-boat needs skillful and intelligent handling, but the cavalry does not use race-horses and high-stepping hackneys do not make good polo ponies.

In conclusion, let it be understood that real progress is just as admissible with standardized fittings as with chaos. We can also learn several lessons from recent events. The Oregon and the Iowa gave a beautiful object-lesson when they cut loose from a base in New York and reached, the one San Francisco, Cal., and the other, Manila, P. I., without having to rely on any supplies other than those they had in the auxiliaries accompanying them. Lieutenant-Commander W. W. Kimball, U. S. N., has proposed that we adopt for sea-going torpedo-boats a similar scheme; that a certain number of boats in a group have as a base a large depot steamer to carry coal, liquid fuel, oil, water, waste, compressed air, spare parts, medical officers, relief officers and men, stores, supplies, repair-shops, etc. This will enable us to shift the base from point to point, and make a fewer number of torpedo-boats cover a wider stretch of coast. With such a long coast-line as we have, we can never afford to have all the torpedo-boats required. This would mean sea-going torpedo-boats for coast defense, and second-class boats for harbor defense, which is technically correct. Torpedo-boat destroyers, operating from a fleet as a base, would accompany said fleet wherever required to assist in protecting it from attack by the torpedo-boats of the enemy; in other words, in operations on the enemy's own coast. This view of the use of destroyers and first and second-class torpedo-boats is in conformity with modern tactical and strategical ideas.

PROFESSIONAL NOTES.

BRITISH AND FOREIGN NAVIES.

The amount now voted annually for the maintenance of the British navy is beyond all precedent. As shown by a diagram in "Brassey's Annual," our expenditure on new construction—which is the foundation stone of naval expenditure—has risen from about £800,000 in 1872-3, up to £9,200,000 during the present financial year, ending the last day of March next. The chief rise has been since the financial year 1893-4, when the total was no more than £3,000,000 sterling.

A government return has just been issued showing the fleets of Great Britain, France, Russia, Germany, Italy, United States, and Japan. The number of vessels in each class, built and building, is given, together with the names, displacement, and armament of each ship and the date of launching of vessels that have been launched. The return is useful, inasmuch as it gives in convenient form figures which bear the official stamp. It might be wished that further details were given, but under the three heads named the chief factors of efficiency are contained, for if we know the size of a ship and her date, we may conclude that the designers worked into her composition a fair balance of advantages, looking on displacement in the light of the "capital the constructor has to work upon." This, of course, assumes equal skill on the part of all designers, which may be far from the truth, but directly one comes to appraise the value of different elements of design, the task becomes so complicated as to be almost hopeless. In 1885, shortly after retiring from public service, Sir Nathaniel Barnaby published at his own expense an exceedingly useful "return," in which the strength of the British, French, Italian, German, and Russian Navies respectively was shown by means of some cleverly devised diagrams. Our most powerful battleships then laid down were the Nile and Trafalgar, designed by Messrs. Barnes and Morgan, Chief Constructors, and the public was informed that these would probably be the last large ironclads built. Exactly what this meant—whether external armor should be abandoned, or that ships of large size should be quite unarmored—was not generally known at the time, and now it is of little consequence, as the prediction has been so completely falsified by events.

The late Director of Naval Construction also stated in his publication that a considerable section of ships had been kept short and low in engine power to encourage the use of sails. That was written nearly fifteen years ago; and in spite of the lessons learned since then, there are, one would almost think, a certain number of naval authorities—the term is convenient—who would approve the same course; at least, that is the impression we get from reading a recent correspondence.

Sir Nathaniel Barnaby refused to believe that the maximum limit of size for battleships had been reached with the 12,000-ton Nile and Trafalgar, and we see by the Admiralty return how this forecast has been amply fulfilled. He appeared, however, to lean to the opinion that side armor would disappear from large ships. It is interesting to note that in 1881 "all the constructors" of the Admiralty, including, therefore, Sir Nathaniel himself, as well as his colleagues, Messrs. Barnes, Morgan, and White, the latter now Sir William White, concurred in recommending a design for a battleship of larger size than any up to then constructed, in which there was an entire absence of side armor, although 28½ per cent of the displacement was devoted to armor. The vessel was not built, and the introduction of high explosives shortly after so revolutionized the conditions of attack and defense that we shall never know whether the Admiralty constructors would have been justified in their advice in case of a naval war.

Turning from the past to the present parliamentary return, we find we have nine 14,900-ton first-class battleships of the Majestic class, and the eight hardly less important 14,150-ton ships of the Royal Sovereign class. Although it is now nearly nine years since the latter vessel was floated, and just over six years since the Magnificent—she was about a fortnight earlier than her sister the Majestic—took the water, yet these seventeen vessels alone form a fleet of two homogeneous and symmetrical divisions unparalleled in offensive and defensive powers (if the two can be separated) by an equivalent number of ships belonging to any foreign power. These magnificent vessels are well supplemented by such ships as the Renown, the Barfleur, and the Centurion, all of which have been proved at sea; and by the six 12,950-ton ships of the Canopus class; whilst coming down to quite the present day we have the six monitors—Formidable, Irresistible, Implacable, London, Venerable, and Bulwark, of 15,000 tons each, and all launched. There have yet to consider, as ships unlaunched, the six 14,000-ton battleships of the Duncan class. To these may fairly be added the older ships, such as the "Admirals" and others, of which we are somewhat apt to speak a little contemptuously, but which would be of supreme importance if the more youthful and vigorous champions of the sea had been well pounded in a close engagement, and had to seek a port to refit. It would be well if the cruiser branch of the navy were as well represented as our line-of-battle. We have some fine ships—big, powerful, and good sea-keepers—but the numbers would not be sufficient for our needs if we were opposed to a combination of powers that heavily taxed our line-of-battle. The most conspicuous feature in this division is fourteen armored cruisers now building—four of 9800 tons, six of 12,000 tons, and four of 14,000 tons. The coast-defense ships, which it is to be hoped will never play an important part in war—for it would be a bad thing for us if they were in request—the special vessels, such as the Vulcan; and, lastly, the torpedo fleet, complete the list of a navy such as never yet has been approached in the history of nations, just as the need for such a navy never before existed during the world's record. Compared to our own majestic array, the foreign lists are not impressive.

If we simply count numbers, we find that we have 70 battleships built and building, France has 36, Russia 24, Germany, 23, Italy 19, the United States 16, and Japan 7. A mere statement of numbers is, however, apt to be very misleading. For instance, our list includes such ships as the Bellerophon, Audacious, Iron Duke, Neptune, and Superb—the two latter purchased during the Russian scare. France includes nothing so ancient as the Bellerophon, which was launched in 1865, her oldest battleships being the Richelieu and Friedland, launched in 1873. On the other hand, some of the older French ships have wooden frames, and can hardly be considered worthy of the line-of-battle even in opposition to our own venerable champions. Russia has one very old ship, the Peter Veliki, launched in 1872. Germany has one of 1874, and two of 1878. Italy has three small ships launched in 1863, one in 1864, and one in 1865; but these are such small craft—from 3851 tons to 4619 tons—that they can only nominally be classed as battleships at all. The Italians, however, have yet the two largest battleships afloat, the Lepanto being 15,549 tons displacement and the Italia somewhat less; whilst our own Formidable and her five sisters are only 15,000 tons each, and the three big Japanese vessels are 15,200 tons each. These two Italian ships, however, as well as other big Italian vessels, have no side armor, though a great weight of heavy projective plates is worked into their structure; but in view of the introduction of high explosive shells and quick-firing guns, it is doubtful whether these two monster vessels would stand long against much smaller craft. They have, of course, other qualities, such as high position of heavy armament and good steaming qualities, to a remarkable extent, considering the date at which they were designed. Of course, high speed is little qualification for the line-of-battle, but is useful rather in getting away from it. The United States ships are all modern, as are those of Japan. The length of the list of battleships possessed by the Japanese is by no means a measure of the power of their line-of-battle fleet; they having, built or building, six ships that would be capable of wiping off the effective list a very long tail of the ships of other powers if the question was put to the test of powder and shot.

If instead of considering the most ancient ships we take those that would doubtless bear the brunt of war standing in the first line of battle, we find that since 1890 we have 38 vessels on the list built and building, 32 of which have been launched. They are all big and powerful ships, the smallest being the Barfleur and Centurion, each 10,500 tons displacement. All but 10 are between 14,000 and 15,000 tons. France has on the list 17 ships commenced since the beginning of 1890. They are much smaller than our battleships, however, ranging between 6691 tons and 12,012 tons, there being only two reaching 12,000 tons, the Bouvet and Suffren. All the French battleships have been launched, but four are not yet completed. The Russians have commenced 18 battleships during the last ten years, 11 of which have been launched. In size the Russian ships are superior to those of France, ranging from 8440 tons up to 13,304 tons, there being three of the latter size in progress; namely, the Borodino, the Emperor Alexander III. and the Orel. Germany has 17 battleships of the 'nineties on the list; four are not launched and three are not completed. Some of them are quite small, seven being 3000 and 4000 tons. The last three on the list, with which comparatively little progress has been made, are the largest, being 11,800 tons each. The others average something near 10,000 tons each. Italy has but four battleships of the 'nineties, the Sicilian and Sardegna, of over 13,000 tons each, and two ships, launched in '97, but not completed, of 9645 tons each. The United States battleships are all of the last ten years. They are 16 in all, six not launched, five launched but not completed, and five in service. They are all above 10,000 tons, except the Texas, of 6315 tons, the three last projected, which are the largest, being 13,500 tons each. If we except the converted Chin Yen, all the six Japanese battleships belong to the last half of the 'nineties, and the smallest is the Yashima of 12,300 tons, whilst, as stated, there are three over 15,000 tons.

To make a comparison between the cruisers of the different countries would be an endless task, and one unsatisfactory however elaborate the list might be. The need for cruisers varies with the maritime importance of a State far more than does the requirement for battleships, which is a much more determinate quantity. It has been laid down as a general principal that there should be three cruisers to every ship of the line, but here again the need varies with the duties for the time being carried out by the battleship. The problem is further complicated by placing armor on cruisers, a plan we seemed to have abandoned until it was revived recently. We have now fourteen armored cruisers in hand ranging from close on 10,000 tons to over 14,000 tons. Of protected cruisers of all sizes, we have 107 built and nine building. There are also fifteen unprotected cruisers; so we have 136 cruisers in all. Some few of these are of ancient date, and hardly to be classed as war vessels. Three special vessels—the torpedo-gunboats, torpedo-boat destroyers, and torpedo-boats—complete this unrivaled fighting fleet. France has 50 cruisers all told. Among her other remarkable craft, she has four submarine boats built and eight apparently in progress. Russia has 26 cruisers in all, Germany 43, Italy 23, the United States 32, and Japan 32. Our need for cruisers is, it need hardly be said, incomparably greater than that of any other power.—*Engineering.*

NAVAL POWER AND COST.

Germany has practically decided to double its navy within the next 16 years. The proposal has passed the Federal Council. This will bring the numbers to 40 battleships, 20 first-class cruisers, with a large addition to smaller craft. This means with docks, etc., an extra vote of 93 million sterling. An immediate increase on the yearly estimates of nearly 10 per cent also brings them up to £3,700,000. Thus Germany has decided to raise at once her naval expenditure from £3,400,000 to £9,650,000 per annum. The French are even more ambitious, for in seven years they propose to spend on new ships yet to be laid down 19 million sterling, and on the completion of ships now in course of construction £9,400,000, altogether 28½ millions on new ships; while harbors, submarine cables, and other immobile works bring the total to over 36 millions. When this is added to the expenditure on other naval services, we have an annual expenditure of nearly 13 millions a year. The new ships to be laid down include six battleships, five armored cruisers, 28 torpedo destroyers (contre-torpilleurs), 112 torpedo-boats, and 26 submarine, or submersile, boats. Russia has not yet embarked on a corresponding programme—not avowedly; but apart altogether from British movements, she cannot be quiescent with Germany's possible menace of her position in the Baltic, as well as in China, where also even France is a contestant, while both Germany and France have even a greater stake than Britain in the Mediterranean, with the Black Sea beyond. Russia's ordinary estimate for this year is nearly 11 million sterling. Britain spends now 27 millions on her navy, against France's proposal of 13 millions and Germany's £9,650,000, and thus we have for four nations 61 million sterling. If we include the expenditure on armies of the four countries, we have for Russia 44½ million sterling, for Britain 45 million, for Germany 41 million, and France 42 million, in all 172 million sterling for the four powers. One of the French government officials remarked in a report on his government's estimates, "What a disastrous weight for modern civilization!" This takes no need of possible—almost inevitable—increase in Britain.

In this war of war expenditure it is important to inquire into the purchasing value of the outlay, for it bears directly on the results of the contest. It is scarcely desirable to enter minutely into details, but it is easy to prove that on the heaviest item—on the munitions of war—we have a great advantage in the less cost of construction. Our latest battleships, with all modern expensive equipment, cost us, complete with guns, £71 odd per ton of displacement, which is as fair a basis of comparison as it is possible to get. The battleships which the French are now building, and those they propose to lay down, certainly not superior to our own so far as the prospective design shows, cost £90 to £95 per ton displacement. Germany's earlier turret ships cost £72, and Russia's new ships about £100. Taking armored cruisers, our Cressy class are to cost about £64 10s. per ton displacement, and the cost of the corresponding ships of the other powers exceed pretty much in the same proportion as with battleships. The comparison might be continued to other classes, but it may be taken generally that French ships are about 30 per cent costlier, and Russian ships 40 per cent dearer, than British ships of equal power. In other words, for the money voted for a battleship for France or Russia, we can build a 5000-ton cruiser also; or we can build four battleships for France's three, all being equal, and six for Russia's four. If we spend the same as both nations together, we get ten for their seven ships. This, however, is a condition which time, with its experience, is nullifying, although perhaps slowly; so we must continue to spend more, even if we get more for our money.

The next question which arises has reference to the ability to bear the burden—a most material consideration, for Micawber's philosophy of household economy and the relation of income to expenditure is as operative with nations as with others. France has admittedly a difficulty in making her revenue at the present time keep up with her expenditure, and the new naval programme has been promised without an increase in taxation. It is, to say the least, difficult to understand how this promise is to be fulfilled; but Britain can afford to view with complacency the prospect of progress in the construction of French ships being delayed owing to the absence of revenue. We have had experience ourselves of this—France's besetting sin to-day—because ere yet our politicians were aroused to the full value of supremacy at sea, this was more or less a chronic condition here. That, however, is long since past. France, as well as Germany, has recognized that there is at least the prospect of continuity of policy if a large addition is authorized at one time; but continuity of construction is not likely to be insured, unless there is at once adequate allowance of money. Sea power costs money. Our taxpayers now fully recognize this, and are ready to back the bill. It remains to be seen how far the Frenchman, the German, and the Russian will accept the same truth. In this financial struggle it is well to consider the weapons available—the countries' resources, as measured by their commerce, their producing capacity, their wealth, and their debts. Space forbids an excursion into minutiæ, even if such were desirable; but recognized statisticians have reduced the facts to simple comparative units, which for most practical purposes are accepted by all.

Britain profits by its preponderating share of the world's commerce, 22 per cent falling to her lot. Germany has just half this portion—10.9; France, 9.2; and Russia, 3.5 per cent. Britain's trade turnover, foreign imports and exports, are also about double those of Germany, and enormously exceed the other two competitors in this war-expenditure game. Germany stands most favorably as to her total debt, but Great Britain excels in material wealth. The figures last available for comparison with all countries are those of 1896, and then Britain's national wealth—first among the nations—was equal to £290 per capita, France's 242*l*, and Germany's 150*l*. When we turn to the debit side of the ledger, France's position is greatly affected, as her debt is more than double that of Britain's, constituting 12 per cent of her wealth, against 5 per cent in our case. In other words, Britain pays interest to the extent of 8s. per capita; while if she had France's debt, she would have to find 20s. from each inhabitant, great and small. Taking the population of Britain at 40 millions, this difference in debt alone should enable us to spend 24 million sterling on our navy without exceeding the average burden in France. This fact alone should be reassuring. The French government official whom we have already quoted has stated that "the burden is heaviest on France, which has not the population of Germany or Russia, nor the wealth of England, but has an unparalleled debt bequeathed by the blunders of former governments." As compared with Germany, our position is not so pronouncedly favorable; but with a national wealth, after allowing for debt, of 11,170 million sterling, as compared with 7937 million sterling, we can better afford to enter upon this new contest with equanimity. The government, thus forced by competitors, can easily play the game.—*Engineering*.

FRENCH SHIPBUILDING.

Once again the French naval programme has shifted, and now—provided always that a fresh programme is not evolved between the time that these lines are written and their appearance in print—the pretty theories of a *guerre de course* are at a discount. The battle squadron is, for the instant, the order of the day, and ten battleships, together with ten large armored cruisers, are spoken of; while the building of two out of those nine submarines that figure in the last parliamentary return is postponed to the *Ewigkeit*, and generally the "new school" has been repulsed. As for the submarines, the countermanding of the two latest is, perhaps, hardly a question of schools, since their particular type-ship, the Narval, does not appear to come up to requirements. She is said, in fine, to exhibit a tendency to float bottom upwards—a state of things that "is expected to interfere with the comfort of her crew, and to hamper her docility," all of which we are quite prepared to believe, given the truth of the reported instability. Experiments with such comparatively unknown factors as submarine boats are, however, one thing; the proposed construction of fighting ships upon accepted models, another. It is this last that we propose to examine.

First, as to cause. Hitherto the French programme has been governed by that of Great Britain, and the opponents of big ships have always pointed out that if France lays down a battleship extra, this country replies with a couple. Therefore, they have argued, it is useless to build battleships with which to fight perfidious Albion. "Fast cruisers" has been the watchwords of this party, and for a year or two its influence has been visible in French shipbuilding. Craft like the Guichen, Chateaurenault, and others, very swift and very little armed, have been built specially for that form of piracy known as the *guerre de course*. After embarking upon this programme, some one in authority seems to have started thinking; and the wisdom of building "a multitude of swift cruisers"—about three is the present total of the multitude—got called into question. Swift the Guichen undoubtedly is, but everything is sacrificed to speed and coal, so that one of our second-class cruisers could, in vulgar parlance, knock her into a cocked hat inside of a few minutes. The result of these deliberations was that the Guichen idea was abandoned, an armed liner being every whit as suitable for piratical purposes. Thereupon armored cruisers were laid down; vessels able to tackle our protected cruisers without much risk, but—except on paper—slower than the Guichen type. To these we have replied with the Cressy class and others, and on this particular line things seem to have crystallized—the Guichen folly is not likely to be repeated. Indeed, the French are now continually asking themselves why, having evolved such a really splendid type as the Dupuy de Lôme, they ever started building anything else. Expense, and the desire of each Minister of Marine to be original, seem to be the two chief reasons why. However, at present the ship-building barometer is at "set fair" in the Dupuy de Lôme direction. A third reason may be casually alluded to. Great Britain never built any "reply" to the Dupuy de Lôme. In the innocence of their hearts the French administration of the period assumed that we recognized some cardinal defect in that ship, and here was an additional argument in favor of something more cheap and showy. Actually our neglect of the Dupuy de Lôme idea should rather be attributed to oversight on the part of past British Admiralties, and the fact that our people, too, were at that time very eager to find something cheap and showy. The Dupuy de Lôme is not a new ship; her armor is by no means of the latest patent; yet, seeing the angle at which it is inclined, we much doubt whether anything under a big gun could get through it. And we incline to fancy that the Dupuy de Lôme could stand up to our Cressy better than the far more modern Dupetet-Thouars.

So much for France's cruiser programme; we now come to the battleships. These, we think, owe the idea of their inception to Germany—it has dawned upon the French that England is not the only country with a navy, and that while the problem of the best kind of fleet to render safe a policy of pin-pricks has been under discussion, the German navy has been creeping up. Already, in case of a Franco-German war, Germany could defeat the French Northern Squadron and blockade the Channel coasts till reinforcements arrived from the Mediterranean. If Germany's programme be left unanswered, then that power will be well ahead of France on the sea. At present, taking vessels of the first and second battle rank, Germany has five completed—the four Brandenbergs and the Kaiser Friedrich der Dritte. Against these France has the Brennus, Bouvet, Jauréguiberry, Charles Martel, Massena, Carnot, Charlemagne, and Gaulois—eight ships, five of which belong to the Mediterranean. True, France has the four Jémappes type, and the Courbet and Dévastation re-armed—or about to be—as well as some other vessels, such as the Magenta, Formidable, and Baudin, of doubtful fighting value, and which Germany has ships to meet. Half of these, again, are at Toulon, and altogether Germany would be in a fairly good position to make things unpleasant.

Of the ships being completed, Germany has one, the Kaiser Wilhelm der Zweite, while France has the St. Louis, Suffren, and Henri Quatre—this last quite a second-class ship. This more than preserves the balance, perhaps, but it does little else. In the matter of battleships building France has one other, the Lena, in hand. Germany has about half a dozen. This spells a probable clear superiority for Germany in the near future, unless Russia helped France, and Russia has not much with which to help despite the parliamentary return. If, therefore, France is not prepared to concede naval superiority to Germany she must begin to build battleships at once, for—neglecting the new programme—Germany, as she is, stands to get ahead of her old rival, and to be able comfortably to beat her in detail. And since it is hardly conceivable that France will permit this, we may look during the next few months to hear a good deal more about the "glorious mastodons," and a good deal less tbout the "brave *sous marins*." While these last have been winning imaginary future victories over perfidious Albion, Germany has plodded along and mended her weak spot in the war of 1870-71. The *guerre de course* ideal, like several other of her ideals, seems likely to cost France pretty dear. Luckily for her, she seems to have awakened just in time; and if the new programme is carried out she will still remain an important naval power.—*The Engineer*.

RECENT BRITISH WARSHIPS.

It is not our intention in the present article to criticize the work, but to take three typical modern types in the British fleet, a battleship, a cruiser, and a torpedo-boat destroyer, and impartially to weigh up the points in which may be said to lie the essential and governing features of these designs.

An impartial observer making a historical survey of the progress of the navy during the past fifteen or twenty years would be struck perhaps as much by the advance in absolute size of typical ships as by any other feature. This is equally true of battleships and cruisers, and in the following remarks we hope to be able to point out the reasons which, in our opinion, have led to development in this respect. We advert to the question of size, since at any given date this point roughly dominates cost, and hence determines what the British taxpayer must give as the price of his determination to have a navy which shall enable this country to maintain its position as mistress of the seas.

As we were enabled in our issue of November 18th, 1898, to lay before our readers a rough outline of the Formidable, together with a few leading particulars of this ship, we have chosen this vessel as the type of the modern British battleship. To recapitulate briefly, her dimensions are as follows: Length between perpendiculars, 400 ft.; length overall, 430 ft.; extreme breadth, 75 ft.; draught, when in normal condition of load, 26 ft. 9 in.; displacement, 15,000 tons. Considering the offensive powers of the ship, we notice that, excepting perhaps a few light guns, the armament is grouped symmetrically at each end of the hull. Taking one end only, say the bow, we have two 12-inch guns of the most modern type mounted in a splendidly protected position, and from their height above water and their large arc of uninterrupted training they should render a good account of themselves if needs be. These are flanked by four quick-firing guns of 6 in. calibre, which fire a little across the bow to nearly 30 degrees abaft the beam. Then on the broadside the four heavy guns and six of the 6 in. quick-firing guns can be brought to bear. The number and disposition of this second part of the main armament has, it is clear, a very marked influence on the dimensions of the ship. In order to avoid interference between the guns they have been placed at considerable distances apart; this in turn has determined the position for the main redoubts, and as it is essential to have these stations well out of the extremities, in order that the seaworthy qualities of the vessel may not be impaired, the length of about 400 ft. is seen to be the least that can be accepted.

For the lighter form of attack the 12-pounder quick-firing guns are distributed uniformly throughout the ship, and form a valuable secondary armament in themselves, as not only are they of especial use as a defense against boat attack, but they supply an efficient means for attacking the lighter works of an enemy's ship.

By reference to the plan previously published, it will be seen how judiciously the guns have been placed; and further, that had a much larger number of guns been installed on board, interference of one gun with the fire of others must inevitably have resulted. This is a point of the utmost importance, in our judgment; we need not name the other disadvantages of more crowded gun-decks, a larger crew, with diminished accommodation for them, etc. After providing an armament, which must be considered excellent, to have each gun placed in such a position that its freedom will be unimpaired by the action of any of the other guns in the ship, and so have its maximum efficiency always attainable, far outweighs the mere glamour of having a larger number of guns, with the certainty that in many cases one gun will be masked by its neighbor, and thus for the time being rendered useless.

Next to the question of guns and their position comes the question of the supply of ammunition, and the means of its convenient transport to the fighting positions. For the big guns this is well provided for by grouping the magazines and shell-rooms vertically between the redoubts, thus arranging for the minimum longitudinal transport of the ammunition. Hydraulic hoists bring both explosive charges and projectiles to the loading positions, which it may be said are independent of the angle of training of the guns, and the rest of the work is easily accomplished.

To minimize labor at the most critical part of an action, a good store of projectiles is carried well up in the redoubts, so that they are within reach without hoisting. The hoist is then entirely devoted to bringing up explosive material, the result being that the officer in charge has the means of accelerating the rapidity of fire to a pronounced degree—a most valuable feature in an engagement. The supply of ammunition to the 6-in. quick-firing guns is arranged in a correspondingly thorough fashion. The magazines and shell-rooms open into roomy lobbies from which convenient and wide passages lead directly to positions beneath the rear of each gun; the ammunition is thus brought to the working positions by the most simple and direct transport, all the time being under protection. As with the large guns, a ready supply of shot and shell is arranged for. Should the action be at close quarters four torpedo tubes, all of the submerged pattern, give an opportunity of using this method of offense in the surest way yet known, and with the minimum of risk to the ship herself. At still closer quarters the ram may be used.

When we note the general defensive powers of the ship, we are of the opinion that the arrangements have been thought out in an equally thorough manner. The armor belt is 9 in. thick, 15 ft. deep, and extends for nearly two-thirds the length of the ship. The material is of the finest quality known. This armor, therefore, worked upon framing of great depth and strength, is so placed as to yield the best possible results in the way of preservation of the ship's stability in action.

At the fore end the side is plated up to the height of the main deck, and down to the point of the ram with special plates 2 in. thick, in addition to the ordinary shell plating. Consequently, when chasing an enemy the liability to perforation of the bow by the lighter guns of the foe is very small. This is an important feature, and conduces greatly to keeping up the speed of the chase. The two protective decks form a double roof over the whole vitals of the ship. The upper is the main deck, and is doubtless intended to compel the bursting of the lighter forms of shells, or, indeed, tolerably heavy shells which happen to strike at small angles. The lower armored deck is of the familiar curved type, and taking position and curvature into account, it forms as complete a protection to the under-water portion of the ship as could well be imagined. These features, together with the division of the ship into numerous water-tight compartments, and a careful disposition of the coal, complete the protection of the hull proper.

Turning to the protection of armament, it is clear that the protection of the 12-in. guns is as complete as it can possibly be made. Rising from the protective deck are two armored redoubts of cylindrical form, which completely enclose the turntables and turntable supports. The armor is 12 in. thick, and is proof against the attack of the heaviest guns at present built, and over each pair of guns is a roomy armored hood to protect the gunners. The 6-in. guns are each placed in a separate casemate with 6-in. armor fronts and 2-in. backs. The protection afforded to their crews is by no means small, and the system of isolating each gun in this way ensures practical immunity to the crew from damage from the fire of small guns and from the explosion of comparatively large shell and the scattering débris necessarily existent in an action.

We have alluded to the transport of ammunition in our remarks on the armament. We will only repeat that it is brought from the magazines to all the guns of the main armament under cover of the armor, thus altogether avoiding exposed transport of explosive material. As regards speed it is estimated that the vessel will attain a velocity of 18 knots on the measured mile at normal draft. After long experience of the admirable speed performances of the vessels preceding the Formidable, we cannot doubt but that this anticipation will be quite realized. It must be fully understood that when this speed is attained in the trial condition, as it assuredly will be, it implies no guarantee that under all and every condition of service the ship will be propelled at this rate of motion. It does imply, however, that a powerful installation of machinery has been fitted on board which, with proper management, will enable a high continuous speed to be maintained while the coal lasts, and in this respect we have no hesitation in asserting that the Formidable is fully equal to, if not somewhat better than, any battleship at present built which she may ever be expected to meet. In our judgment it is unnecessary to dwell further upon the qualities of the modern British battleship. Much could have been said as to the thoroughness of the equipment in many other respects, the arrangements made for the comfort of the officers and crew, etc., but space forbids.

When we come to consider a typical cruiser, we are face to face with the fact that we can hardly find a type of ship so completely representative of the general body as is the case with the battleship. While, of course, there have been differences in designs of battleships, the battleships within the past ten years built or building, thirty in all, have all ranged within narrow limits of displacement; the Renown being at the lowest point of the scale, with a displacement of 12,350 tons, and the vessels of the Formidable class at the other extreme, each with a displacement of 15,000 tons. A much greater variation in the size of cruisers has been found to be necessary in order that the multifarious duties devolving upon the fleet may be satisfactorily carried out. During the same period as that mentioned above, cruisers have been built ranging in displacement from about 3000 tons up to normal displacements of over 14,000 tons.

When we consider the ever-increasing growth of our mercantile marine, and the increase in average speed of voyage which has been made in recent years, there is not the slightest doubt that the Admiralty has done well in determining to lay down four ships of the Drake class, with a view to the protection of our great maritime routes, and as an answer to the policy pursued by other nations in building commerce-destroyers; it being tolerably evident that, excepting ourselves, there is no other country in the world whose commerce is very much worth a serious effort to destroy. From the particulars of the vessel which have been made public from time to time, we think it may fairly be inferred that the key to the design is speed, a high speed under measured mile conditions, and kept up for such a time as will ensure that it is no mere spurt, but that it affords every ground for expectation that a high rate will be maintained for the whole period over which the coal will last. Associated with the question of speed over prolonged periods, is the question of how much the speed is likely to fall off under stress of weather; the large size of these ships and their great height of freeboard, especially forward, make it certain that they will suffer comparatively little in this respect. Coming to particulars, we may say that the dimensions are as follows: Length between perpendiculars, 500 ft.; length over all 533 ft.; breadth extreme, 71 ft.; normal draft of water, 26 ft., this draft, as in the case of the Formidable, making a passage through the Suez Canal both a certain and easy operation.

We have in general terms already alluded to the matter of speed in this vessel. This point stands out prominently both as a means of offense and of defense. It will enable her to overhaul any vessel in the course of a comparatively short time. When the character of any strange vessel is made out, even should the Drake be under easy steam at the time with a large portion of the boiler power not in use, the water-tube boilers which will be installed will enable steam to be raised in the minimum time, and a chase ought to be a matter of short duration. Her armament is well balanced. A 9.2-in. gun of modern type is mounted on the forecastle, at a commanding height above water, and with a horizontal arc of 270 degrees; a similar guns is placed aft, with the same arc of training. The remainder of the main armament consists of sixteen 6-in. quick-firing guns, symmetrically disposed, and of which four can fire right ahead, four right astern, and eight over a large arc of training on each broadside. The remainder of the gun armament is made up of fourteen 12-pounder quick-firing guns, with small boat guns and Maxims in addition. Though an enormous space in the ship must be taken up by machinery and boilers, room has been found for the submerged torpedo tubes.

Equally with the Formidable, the great care with which the armament has been disposed is manifest; each gun has a very large and uninterrupted arc of training. We must not enter into any details regarding the service of ammunition, merely remarking that it is quite as thorough as in the Formidable, and that under these circumstances the gun will be quick-firing in actuality as well as in name.

When we consider the defensive qualities of the ship, it is evident that the most active defense is undoubtedly her speed; she should, therefore, be able to avoid action with an enemy more powerful than herself. As a means of protection to the hull it is to be noted that an armor belt 6-in. thick is worked over about half the length amidships, and extending to the height of the main deck. At the after end of the belt the protection is completed by a transverse armored bulkhead. Forward, the armor extends to the bow; the thickness is somewhat diminished, but its depth below the water-line is maintained, and the height above water is increased by at least 8 ft.; thus strongly fortifying the bow against the attack of a retreating foe, and as in the Formidable, minimizing the chances of retardation of speed due to perforation of the bows. Two protective decks are worked in accordance with the latest practice.

The protection to the armament next calls for notice. On a cruiser, however large, amor in any quantity is a serious factor in the situation if a high speed is aimed at, and it is no wonder that the designers have found it impracticable to give as much protection to the armament as in the case of the heavier and slower battleship. The heaviest guns, however, come in for a substantial measure of armored protection, and each 6-in. gun is isolated in an armored casemate with front plates 6 in. thick.

The arrangement for the supply of ammunition is of the same general character as that we have already described in the case of the typical battleship.

It is expected that 30,000 indicated horse-power will be developed in the course of the eight hours' official trial with natural draught in the stokeholes. After the successful results on trial of all the recent cruisers and battleships, we cannot doubt but that this enormous power has been fully provided for, and that it will be developed under such circumstances as will make it quite certain that it could easily be realized at any future period in the history of the ship.

So much then for the two principal types of the navy. If it be urged that they are unnecessarily large for the services expected of them, it is for those who hold such views to point out specifically in which direction improvement may be sought, or what items at present embodied in these designs can be dispensed with without sacrificing efficiency, and while maintaining the small medium of comfort at present preserved to the officers and men. It is certain that the task of the critic is by no means an easy one. The constructive and engineering staff at the Admiralty is fortified in its practice by a mass of experience in the practical performances of the ships which they have turned out in the past, compared with which the experience of the similarly placed officials of other countries is but small, and against which the opinion of irresponsible and often ill-informed critics can be safely neglected.

The last type of vessels which claims our attention is the torpedo-boat destroyer, and though occasionally we hear doubts expressed as to the wisdom of building vessels of this type, there has been hardly any criticism of the general features of their design.

The genesis of the small but exceedingly fast boat may be said to have commenced with the Miranda, built by Messrs. Thornycroft more than twenty-five years ago. Small as she was she attained a phenomenal speed. Following upon her performance great numbers of lightly armed swift vessels have been built for our own and for other navies. The smaller types, generally carrying a gun or torpedo armament alternatively, and adapted for keeping the sea for restricted periods only, are called torpedo-boats. The larger types carry both gun and torpedo armaments; they can keep the sea for extended periods, and owing to their considerable size it has been found possible to install machinery which gives them a decided superiority in speed over the torpedo-boats, enables space to be found for a relatively large coal supply, and gives fairly good accommodation for officers and crew; these vessels are called torpedo-boat destroyers.

The greater number of these vessels have speeds of about 30 knots. In a few of the latest boats an endeavor has been made to attain somewhat higher speeds without much increase in size, the Albatross being one of this latest type. Her dimensions will be found in the accompanying table:

	Formidable.	Drake.	Albatross.
Length	400 ft.	500 ft.	227 ft.
Breadth	75 ft.	71 ft.	21 ft. 3 in.
Mean draft	26 ft. 9 in.	26 ft.	8 ft.
Displacement	15,000 tons.	14,100 tons.	400 tons.
Horse-power	15,000 (natural draft).	30,000 (natural draft).	7500 (forced draft).
Speed	18 knots.	23 knots.	32 knots.
Coal supply (normal)	900 tons.	1250 tons.	50 tons.
" (bunkers full)	2000 tons.	2500 tons.	100 tons.
Armament	Four 12-in., Twelve 6-in. B.L. Eighteen 12-pr. Q. F. Fourteen small'r Q. F. and machine guns. Four torpedo tubes.	Two 9.2-in. Sixteen 6-in. B.L. Fourteen 12-pr. Q. F. Three 3-pr. Q. F. Two torpedo tubes.	One 12-pr. Q. F. Five 6-pr. Q. F. Two torpedo tubes
Armor	9-in. sides. 12-in. barbette. 6-in. casemate. 2—3-in. deck.	6—2-in. sides. 5-in. casemates, 6-in. barbettes.	—

The armament consists of one 12-pounder and five 6-pounder guns, all quick-firing, and two revolving torpedo tubes capable of firing the largest pattern service torpedo. The 12-pounder gun is mounted on the conning tower; one 6-pounder is placed on an elevated pedestal on the middle line at the after end of the ship; two 6-pounders are so situated as to be able to fire directly ahead, and the others are on the broadside amidships. All these guns have exceptionally large arcs of training.

The hull structure and fittings are made as light as practicable, consistent, of course, with a due regard to durability; the better to secure this latter point, the greater portion of the material is galvanized, while to obtain the requisite strength, with the minimum of weight, steel of a specially high-grade quality is used. It is in the machinery of this vessel that the most striking evidences of enterprise are manifested. By the adoption of quick-running machinery, and water-tube boilers of the small-tube type, it has been possible to develop about 45 indicated horse-power per ton of propelling machinery for short periods.

In order that this performance may be the more thoroughly appreciated, we need only remind our readers that in large ocean-going mercantile steamers with slow-running engines and with cylindrical boilers, only about 6 indicated horse-power per ton of machinery is developed, and in modern large warships with moderately fast-running engines, and with water-tube boilers of the large-tube type, about 9 indicated horse-power per ton of machinery is obtained. Of course, these latter figures being based on the power which can be continuously developed, the comparison is not a direct one, but they enable some idea to be formed of the great disparity existing between the installation of machinery of the torpedo-boat destroyer and that of large ocean-going steamers.

What we have said about the Albatross applies pretty generally to the torpedo-boat destroyers as a class, and it reflects the greatest credit upon the Admiralty and the various builders associated with them in so successfully solving the problems connected with the production of the large fleet of these vessels which this country now possesses.—*The Engineer.*

THE FLEETS OF THE POWERS.

The number of war vessels of all kinds built or building in the various countries is as follows:

Great Britain.—Battleships, built, 53; building, 17; armored cruisers, built, 17; building, 14; protected cruisers, built, 107; building, 9; unprotected cruisers, built, 15; coast-defense vessels, armored, built, 13; special vessels, built, 3; torpedo vessels, built, 35; torpedo-boat destroyers, built, 75; building, 33; first-class torpedo-boats, built, 95; building, 2—total, 488.

France.—Battleships, built, 31; building, 4; armored cruisers, built, 8; building, 12; protected cruisers, built, 36; building, 4; unprotected cruisers, built, 14; coast-defense vessels, armored, built, 14; one special torpedo depot ship; torpedo vessels, built, 15; torpedo-boat destroyers, built, 2; building, 10; torpedo-boats, built, 219; building, 47; submarine boats, built, 3; building, 9—total, 428.

Russia.—Battleships, built, 12; building, 12; armored cruisers, built, 10; building, 2; protected cruisers, built, 3; building, 8; unprotected cruisers, built, 3; coast-defense vessels, armored, built, 15; building, 1; special vessels, built, 5; building, 2; torpedo vessels, built, 17; torpedo-boat destroyers, built, 1; building, 35; torpedo-boats, built, 174; building, 6—total, 306.

Germany.—Battleships, built, 18; building, 7; armored cruisers, built, 3; building, 2; protected cruisers, built, 13; building, 4; unprotected cruisers, built, 21; coast-defense vessels, armored, built, 11; special vessels, built, 3; torpedo vessels, built, 2; torpedo-boat destroyers, built, 1; building, 10; torpedo-boats, built, 113—total, 208.

Italy.—Battleships, built, 15; building, 4; armored cruisers, built, 3;

building, 4; protected cruisers, built, 15; building, 3; unprotected cruisers, built, 1; special vessels, built, 2; torpedo vessels, built, 15; torpedo-boat destroyers, building, 11; torpedo-boats, built, 144; building, 10—total, 227.

United States.—Battleships, built, 5; building, 11; armored cruisers, built, 2; building, 3; protected cruisers, built, 14; building, 7; unprotected cruisers, built, 6; coast-defense vessels, armored, built, 19; building, 4; one special vessel; torpedo-boat destroyers, built, 1; building, 19; torpedo-boats, built, 15; building, 14—total, 122.

Japan.—Battleships, built, 3; building, 4; armored cruisers, built, 3; building, 4; protected cruisers, built, 14; building, 2; unprotected cruisers, built, 9; coast-defense vessels, built, 4; one torpedo vessel; torpedo-boat destroyers, built, 8; building, 4; torpedo-boats, built, 29; building, 29—total, 114.—*The Engineer.*

THE UNITED STATES HARBOR-DEFENSE VESSELS.

One of the provisions of the session of Congress last year was an allowance for the construction of four harbor-defense vessels for the United States Navy. The vessels are to be of the Monitor type, and to be built after the plans furnished by the Navy Department. On October 1st bids were opened, and awards have already been made, the costs ranging from $825,000 to $875,000. Three of the ships will be built on the Atlantic coast, and one on the Pacific, and a maximum of twenty-seven months is set by the bidders for the completion of the work.

The primary purpose of the ships is for harbor-defense duty, but their sea-keeping features have been carefully considered that they may be the better fitted for rapid cruising from one port to another than the vessels of the Monitor class now in active service. In points of equipment and mechanical facilities the vessels are very decided advances upon anything of their order now in the United States Navy, and, within the reasonable scope of their powers and application, should prove very formidable fighting-machines.

A description of one ship applies equally to the others, and for example the Arkansas will be described. The ship will have a water-line length of 225 feet, the stem being carried well forward below the water and formed into an effective ram; she will have a maximum beam of 50 feet, and, upon a normal displacement of 2700 tons, will draw only 12½ feet of water. Her possible usefulness about the West Indies or in the shallow waters of the Gulf is apparent at once.

The hull is of steel, unsheathed, with an inner bottom reaching up to the armor shelf, and ranging fore and aft throughout nearly the whole length of the ship. There is the usual subdivisioning of the intramural space, as well as of the whole interior of the craft. In the double bottom, just below the boilers, feed-water will be carried, leaving just so much more room for other purposes in the boiler space. This is a departure from the service practice heretofore, and is being adopted for some of the other new ships.

The hull will be guarded by a continuous band of armor extending from the main-deck line down to a maximum depth of 30 inches below the water-line amidships, but reaching only down to the water at the stern. This armor will have a maximum thickness of 11 inches at the deck-line throughout the region occupied by the engines, the boilers, and the magazines, tapering thence to the armor-shelf well below water. Forward and abaft the vital space, the armor will be graduated by easy steps till it terminates at the bow and the stern in thicknesses of 5 inches. It is said to be the present intention of the Department to have this armor treated by the Krupp hardening process—really the Harvey process carried farther into the plate; and if this be so the defensive properties of the steel will be considerably increased—perhaps as much as 20 per cent. The protective deck, or, more properly, the main deck, will be composed of two thicknesses of ¾-inch plating, of which the upper course will be of nickel steel. This will be sufficient defense against the acute angle at which most plunging shots will have to strike. This main deck will be planked, but, being exposed to the weather, will not be fireproof.

A five-sided superstructure will occupy the central portion of the main deck. In the lower half will be quartered some of the officers, and there too will be the galley, the armory, some wash-rooms, and spare space for the housing of part of the crew if so desired. On the next deck above, i. e., the superstructure deck, will be placed the major part of the rapid-fire portion of the battery. The hammock berthing will also be in the superstructure on that deck, lending a very mild protection to the gun-crews of some of the smaller pieces. On the bridge or uppermost deck will be carried the chart-house, the boats, and all of the 6-pounder rifles. This and the deck just below, like the main deck, being exposed to the weather, will not be fireproofed; but the berth deck being under cover will be covered with linoleum placed right upon the fundamental plating. Wherever possible, woodwork has been omitted and supplanted by light metal bulwarks, etc., but where found needful for the sake of health and the saving of weight the wood used will be carefully fireproofed.

All hatch coamings are raised well above the main-deck line, and those in the open forward are carried high enough to permit of their being left open even when the deck forward is well awash with broken seas. By this means the crew space forward on the berth deck can be well lighted and comfortably ventilated when cruising in fair weather—a desideratum of prime importance when doing duty in warm southern waters. In heavy weather these hatches would be battened down, and the fresh-air supply would then be drawn down through the mast and the big ventilators, while a good deal of the foul air of the boiler spaces, especially, would be carried up between the double casings of the smoke-stack. The Monitor is not naturally a cool craft when under steam, but everything has been done in these ships that could be done to make them much more comfortable than any of their predecessors, and there is no doubt but that they will prove so. Electric fans and electrically propelled blowers will furnish most of the induced ventilation.

The ship will be driven by twin screws, actuated by two triple-expansion engines, which will be placed in one water-tight compartment. These engines will be of the vertical inverted-cylinder direct-acting type, each with a high-pressure cylinder of 17 inches, an intermediate-pressure cylinder of 26¼ inches, and a low-pressure cylinder of 40 inches, the stroke of all pistons being 2 feet. The collective indicated horse-power of the propelling and the circulating pump engines will be 2400 when the main engines are making in the neighborhood of 200 revolutions a minute. Steam will be supplied at a working pressure of 250 pounds, by four water-tube boilers, having a total grate surface of quite 200 square feet and a total heating surface of 8800 square feet, and capable of supplying all the steam on shipboard when running at full power.

The amplest possible means have been provided for a supply of cool air for the engine- and the boiler-rooms when under steam. The armored ventilator abaft the smoke-stack will be the main duct, while the two smaller ones just forward will answer the double purpose of air-shafts and ash-hoists. All of these ventilating passages will be guarded by armor gratings to keep out explosive shell, and the big, main ventilator will be surrounded by several inches of armor up to a height of 4 feet above the main-deck line.

The vessel will be lighted by electricity, while the turret mechanisms and all the ammunition hoists will be actuated by the same energy. By the adoption of electricity so general, the presence in long passages of heated steam-pipes is obviated, and in this way alone a very considerable reduction of temperature will be effected under service conditions. The main battery will consist of two 12-inch breech-loading rifles; the secondary battery will be composed of four 4-inch rifles; while the auxiliary battery will include three 6-pounders and four automatic 1-pounders. The 12-inch guns will be mounted in a single barbette turret of the balanced type, having an inclined face with a pitch of 42 degrees. The armor for the turret and the barbette will be 11 inches thick, and will be treated by the Krupp process. The total sweep, or arc, of fire of these two guns will be 300 degrees, leaving a dead angle, dead aft, of only 60 degrees, which could be easily covered by a slight swing of the ship to either side. The four 4-inch guns will be mounted on the four principal corners of the superstructure deck, where they will command an enviable field of fire. These guns will be protected by shields. The 6-pounders will be mounted on the bridge deck, while the 1-pounders will be placed on the hammock berthing amidships, and up in the single top of the military mast. The 12-inch and the 4-inch guns are to be designed for smokeless powder, and it is promised that they shall be a considerable advance upon the pieces of like caliber, of native design, now in service. For a ship of her size, the Arkansas will be a very effective fighting machine, and more than an equal, within her field of action, for any craft of like displacement. There will be a conning-tower 7½ inches thick, just below the chart-house and abaft the turret, and all means of communication will be led thence through an armored tube 3 inches thick down below the main deck.

The ship will carry two search-lights—one forward on the mast and the other on a stand at the after-end of the bridge deck. There will also be the usual outfit of electric signals and side and running lights. Modern facilities in every direction will add to the comfort and convenience of the officers and crew and to the working efficiency of the craft, and nothing will be spared that can bring the vessels typically up to date in every sense. The bunker capacity untrimmed will be 200 tons of coal, and that amount will be carried upon the normal displacement. More, of course, can be carried in an emergency, but the normal allowance at the ordinary cruising rate of speed will be amply sufficient to give the ship a considerable radius of action.

These vessels have really been called into being through the pressing needs of the growing ranks of the naval militia for proper training-schools aside from vessels temporarily detailed for such service. In many instances only the ancient Monitors of the war of the rebellion were assigned for that work, and with their old boilers and engines and muzzle-loading smooth-bore guns, they were not such drill-grounds as the modern seaman and the volunteer officer need. With the single exception of torpedo instruction, these four harbor-defense vessels cover practically all that is needful in a general preliminary education in naval warfare of to-day, and in that capacity alone the ships will pay well for their construction.

The electric generating plant is to consist of four units, each unit to have an engine, dynamo, and combination bed-plate, and each dynamo a rated output of 400 ampères at 80 volts. This plant will supply motive energy for the ventilating blowers, and for all ammunition hoists and the mechanisms controlling the turret and the loading of the two 12-inch rifles, and power for all the lights in the ship. The complement of the ship will consist of something like 130 persons, with berthing space for a larger crew if necessary.—*The Engineer.*

OUR LATEST PROTECTED CRUISER, THE ALBANY.

The Albany in all essential points is an exact duplicate of the New Orleans, the changes which have been made in her being "such," in the language of one of our naval constructors, "as were absolutely necessary to render her habitable for Anglo-Saxons." The alterations have been chiefly in the living quarters of the officers and crew, some of them being necessary to meet the differences in climate between the tropics and our more northerly latitudes, and others being necessitated by the fact that the accommodations, sanitary and otherwise, which seemed to have sufficed for the South American republic would have been absolutely unendurable for the men of the American Navy. An improved system of ventilation has been installed, the officers' quarters have been rearranged and enlarged, and additional berthing space has been provided for the crew. Considerable alterations have also been made in the dynamo-room. These modifications have been carried through without in any way impairing the fighting efficiency of the vessel.

The Albany was launched at Newcastle, January 14, 1899. She is 330 feet in length over all, with a beam of 43 feet 9 inches, and a maximum draft of 15 feet 10 inches; and her displacement, according to figures furnished by her builders, is 3402 tons with ammunition, stores, coal and water half consumed, and with all ammunition, stores, coal and water on board, 3954 tons. She is driven by twin engines and screws; her maximum indicated horse-power is 7500, and her speed, as determined in recent trials in England under the official representative of our navy, was 20.73 knots for four hours under forced draft and 19.3 knots on a run of six consecutive hours under natural draft. The vessel is sheathed and coppered and will, therefore, be especially suited for service in tropical waters.

The Albany is thoroughly representative of the latest trend of ideas in the construction of protected cruisers. Like the best of her type she is distinguished by her good speed, generous coal capacity, considerable length in proportion to beam, enabling her lines to be carried out with great fineness and beauty, and by her powerful armament and her ability to deliver great energy of fire through a widely extended zone. In respect of defensive qualities, however, like all protected cruisers, she is certainly weak and open to attack. She is entirely devoid of vertical side armor, and her protection against the entrance of projectiles into the vitals consists merely of a curved deck of steel assisted by coal bunkers in the wake of the engines and boilers at the water-line.

The main battery of the Albany is made up of six 6-inch and four 4.7-inch rapid-fire guns, and the secondary battery consists of ten 6-pounder rapid-fire guns, eight 1-pounders, and two Colts. The whole of the main battery is of the long 50-caliber type, manufactured by the builders of the vessel. The disposition of the battery is as follows: One 6-inch gun is carried on the forecastle deck, another aft on the poop, and four others are carried in sponsons on the main deck in the waist of the vessel, two of the latter being forward on either beam, and two aft. The sides of the vessel are cut away so as to allow these four guns on the main deck to be fired directly forward or astern parallel with the axis of the ship. The 4.7-inch guns are carried in broadsides on the main deck between the 6-inch guns. The battery of 6-pounders is carried on the main deck, forecastle and poop, two of these being in the bow, two in the waist, and two astern on the main deck, while the other four are carried on the forecastle and the poop. The vessel is provided with two military masts upon which there are no less than four separate fighting-tops in which are distributed the 1-pounders and Colts. The arrangement of the battery enables the vessel to concentrate the fire of three 6-inch guns dead ahead and astern, while the broadside fire consists of four 6-inch and two 4.7-inch guns.

The 6-inch gun of the New Orleans is carried in a trunnion sleeve or seating, in which it slides. It is held in the forward or loading position by coiled springs, inclosed in two cylinders which are attached to the seating. Attached to the gun are two pistons which travel in the cylinders, the latter being filled with glycerine, and it is the combined resistance of the springs and of this glycerine to the movement of the pistons which serves to take up the recoil. After the recoil the gun is returned to the loading position by the action of the coiled springs, which were compressed during the recoil. The breech of the gun and the crew are protected by a large shield of 4-inch Harvey steel. This type of gun has fired seven rounds in 61 seconds, and the 4.7-inch gun has a record of five rounds in 22 seconds. The 6-inch gun fires a 100-pound projectile with a muzzle velocity of 2600 foot-seconds and a muzzle energy of 4687 foot-seconds. This is equal to a penetration of 20½ inches of iron at the muzzle. The 4.7-inch guns have the same velocity, and a muzzle energy of 2109 foot-tons with a penetration of iron at the muzzle of 15½ inches. At 2500 yards the velocity of the 6-inch and 4.7-inch guns is 1790 and 1558 foot-seconds, respectively, the energy at that distance being in the 6-inch gun 2224 foot-tons, and for the 4.7-inch guns 757 foot-tons.

For protection the Albany relies mainly upon a curved deck, which is 1¼ inches on the flat and 3 inches in thickness on the slopes, the latter extending along the sides from the flat deck, which is slightly above the water-line, to a junction with the sides of the vessel several feet below the water-line. This protection is reinforced by the large coal-bunkers, which are extended along the berth deck on either side amidships, and present a horizontal thickness on each side of 8 feet of coal. The normal coal capacity is 512 tons and the bunker capacity, with full stowage, is about 800 tons.—*Scientific American.*

GERMANY'S LATEST BATTLESHIP.

The Germans, in the design of ships of their new navy, have shown marked originality, and there are some respects in which their vessels are superior to those of most other navies. The conspicuous feature is the admirable distribution which has been made of the numerous armament of the Kaiser Friedrich III. It is generally agreed among naval designers that the separate units which make up the total armament of a warship cannot be too widely separated. The terrific powers of destruction of a bursting shell make it desirable to localize its effects as far as possible, and this feature is well worked out in the German ship. The thirty-four guns in the main battery are distributed upon four decks, and the guns upon any one deck are widely separated from each other. Moreover, the guns are all carried either in complete turrets or in separate armored casemates.

Another excellent feature of the vessel is, that every gun is of the rapid-fire pattern, not even excluding the four heavy armor-piercing guns of the main battery. A third feature in which the ship is thoroughly up-to-date is the comparatively small size of the heaviest guns, the largest of which are only 9.49 inches caliber. The use of such light guns means a great saving in dead weight and a proportionate increase in the fighting qualities of the ship in the way of more speed, larger coal capacity, or a more numerous armament.

The Kaiser Friedrich III. has the moderate displacement of 11,130 tons, which is 1000 tons less than that of the Japanese battleship Fugi, over 2000 tons less than our latest battleships of the New Jersey type, and the Majestic, of the British navy, exceeds it by 3700 tons.

It is probable, however, that Germany intends to use these battleships more for coast-line defense than for foreign service. The Kaiser Friedrich III. would have to be increased in displacement by from 1200 to 1500 tons, if she were to carry the coal, ammunition, and stores sufficient for an extended service during war times in far distant waters.

The guns of this vessel are to be carried at four different stages of elevation above the water. The lowest guns are two 9.4-inch rapid-fire guns in the after turret on the main deck, and the four 5.9-inch, which are carried in casemates, two forward and two aft, on the same deck. On the spar deck above are mounted fourteen 5.9-inch guns. Six of these are carried in one-gun turrets on the broadside and eight in casemates, four forward and four aft. Forward in a turret, on the superstructure deck, and at a height of over 30 feet above the water, is the forward pair of 9.4-inch rapid-fire rifles, and, at the same elevation, on the superstructure deck, are ten 3.3-inch rapid-fire guns. Above these again, at a height of 46 feet above the water-line, on the upper bridge, is a pair of 3.3-inch rapid-fire guns. The all-around fire which is aimed at in this distribution is unusually powerful. The vessel can concentrate two 9.4-inch, eight 5.9-inch, and six 3.3-inch rapid-fire guns ahead; four 9.4-inch, nine 5.9-inch, and six 3.3-inch on either beam; and two 9.4-inch, eight 5.9-inch and four 3.3-inch astern. The armor on belt is 11¾ inches amidships, tapering to 6 inches at the ends. The main turrets carry 9¾ inches of armor and the casemates 6 inches. It will be noticed that the vessel is driven by triple screws, an arrangement which has been found to give excellent results in our own Minneapolis and Columbia.

The thick armored deck divides the vessel vertically, the most vulnerable portion of the ship, that is, the boilers, engines, magazine and steering gear, all of which are commonly known as the "vitals," lying beneath the armored deck and below water-line. They are known as vitals because a shell bursting among them might easily put the ship out of action, and it is absolutely imperative that this portion of the vessel should be secure against attack. The thick armored belt at the water-line, the cellulose or, as in this case, cork protection, also at the water-line, the complete armored deck, and the fact that these vitals are well below the water-line render the chances of a shell entering the vitals very remote.

Above the armored deck are the guns and the living quarters for the officers and crew. At the extreme after end of the vessel are the quarters of the commander, captain or admiral. The officers' quarters are situated on the afterpart of the main deck and spar deck, while the crew's quarters are to be found on the same deck forward of the center line of the ship.

The weakest point of this type of ship is found in the scanty protection afforded to the ammunition in its passage from the magazine to the guns, and in the lack of armored protection for the bases of the turrets. In the case of a ship like our own Maine, there is a continuous wall of armor from the water-line to the top of the turrets; but in the Kaiser Friedrich III. the only connection is a small ammunition tube. In a fight at close range the endurance of the Maine would be considerably greater than that of the German ship.—*Scientific American.*

THE RECONSTRUCTED CRUISER ATLANTA.

The work of reconstruction has been very complete. The old horizontal, compound engines have been changed to triple-expansion by the addition of a high-pressure cylinder. At the same time the eight old, single-ended, Scotch boilers have been removed and replaced by two single-ended Scotch boilers and four Wilcox and Babcock water-tube boilers, the Scotch boilers carrying 180 pounds of steam and the Wilcox and Babcock 250 pounds. This change has not only greatly increased the boiler capacity, but it has reduced the bulk of the installation sufficiently to allow the construction of an athwartship coal-bunker, which will increase the total coal capacity of the vessel by 80 tons, or about 17 per cent. These changes are expected to result in an increase of the vessel's speed from 15½ to 17½ or possibly 18 knots speed.

The ship's main battery, which was formerly of the short-caliber, slow-firing type, has been entirely renovated. All of the guns, including the two 8-inch bow and stern weapons, are of the rapid-fire type, the sights being mounted upon a sleeve in which the gun recoils and the breech mechanism being brought fully up to date. Although the new 8-inch guns are not officially known in our navy as rapid-fire, they do actually possess the characteristics which mark the so-called rapid-fire guns of this size in foreign navies.

The lessons of the late war have been turned to good account in the work of reconstruction; for the Atlanta, on and above the main deck is absolutely stripped of combustible material; and if she is ever called upon to fight, there will be no fear of her being prematurely put out of action by the burning up of the wooden decks, bulkheads, and furniture. All of this wood-work was more or less, and generally more than less, highly inflammable. In the process of refitting, the wooden bulkheads were removed and the panelings stripped from the ceiling and from the outboard turtle-back. Their place was taken by corrugated metal for the bulkheads, a coating of cork paint for the ceiling, and a covering of asbestos on the outboard walls. The wooden furniture is replaced by furniture of metal, one piece of which is a neatly designed roller-top desk. The asbestos sheathing possesses the requirements of a non-conducting, incombustible, splinter-proof covering. The asbestos fire-felt is laid over wire cloth which is attached to a framework of light angle-bar, carried between the ship's frames or bulkhead-stiffeners. The felt is flush with the surface of the frames, or the edges of the angle-bars, and asbestos millboard, three-eighths of an inch thick, is placed over the fire-felt to secure a smooth, hard finish, and it is held in position by galvanized iron moldings. The millboard is coated with sizing to prevent absorption, then painted with white enamel and striped with gold, the result being a pleasing panel effect. The asbestos sheathing has a light, cheerful appearance; it is warm in winter, cool in summer, and is free from the "sweating" which is such an insuperable objection to the use of the plain steel partition. The changes in the captain's cabin are typical of the work which has been done throughout the whole of the officers' quarters. One notable change which is conducive to convenience and cleanliness is the designing and putting in position of a folding metal berth, which in the daytime can be folded against the wall and screened by a curtain. For reasons which are only too well known to those who sleep at sea, the substitution of an open and accessible metal berth for the old, fixed wooden bunk will be greatly appreciated.

There are the new metal rifle-racks for the marines, metal lockers for the gun division, the substitution of wire screens in place of wooden bulkheads for the executive office, metal ladders and numberless other substitutions of metal for wood. On the superstructure deck the old wooden chart-house has made way for a new steel structure with circular lights.

The work above the main deck looking to the safety of the ship from fire finds its match below deck in an entirely new system of water-tight, electrically operated doors. Briefly stated, the absolutely essential elements of a successful water-tight door system are, first, that every door may be closed simultaneously and instantly from the bridge or some central station, and that some telltale announcement shall show that they are closed; secondly, that it shall be possible to raise and lower each door independently, and from either side of the door, without conflicting with the operation from the bridge; thirdly, that it shall be possible to close the door either against a rush of water or through coal which may have accumulated in the doorway. These features, with others of minor importance, are all fulfilled in the present instance. The clear opening of the door can be of any desired size; for coal-bunkers, it is generally about 4 feet 6 inches by 2 feet. The door is a steel plate riveted to a sliding frame. The guide-frame of bronze is bolted to the bulkhead, the guides being tapered one-tenth of an inch to the foot. The sliding-frame is made with eleven wedges of the same taper as the guides, there being four on each side, two on top and one on the bottom. The surfaces nearest the bulkhead of both the guide-frame and the sliding-frame are scraped surfaces which form a water-tight joint by the wedge action which occurs during the last half-inch of closing. The guide-frame is open at the lower edge to prevent clogging or jamming.

The door-plate carries a bronze rack into which gears a pinion keyed to a horizontal shaft which is carried at the top of the guide-frame. This pinion engages a smaller pinion on a second horizontal shaft, at either end of which is keyed a worm-wheel, which in its turn engages a worm. The worm-shaft passes normally through the bulkhead and is driven by a one-horse power electric motor, which is carried in a watertight casing on the opposite side of the bulkhead. Crank-shafts are provided, which slip over the hexagonal end of the worm-shaft on either side of the bulkhead, and may be used for hand operation of the doors. The motor is compound-wound and of the short shunt type, the short shunt coils being relatively weak and wound outside the series coils. The circuits are so arranged that for raising the door only, the series coils are in circuit, giving a quick and easy starting; while for closing the door, where it may be necessary to cut through coal or other obstructions, the shunt and series coils are both in circuit. The current is controlled by a three-point spring lever switch on each side of the bulkhead. The switch is normally in its central position, in which the door-closing circuit may be completed from the bridge or from any central station in the ship. The door-opening circuit can be completed only at the door, and this is done by moving the lever to the right or left, operations which raise or lower the door.

The operation of this system is as follows: In case of an emergency such as a collision, the officer on the bridge can immediately close every water-tight door throughout the vessel, a small signal lamp at the bridge, or other selected station, lighting up during the movement of the door and going out as soon as the door is closed. If any of the crew should be shut in a water-tight compartment, or should it be necessary to pass from one compartment to another after the doors have been closed from the central station, all that is necessary is to turn the spring lever at the particular door, when it will open, the lever returning to the central position and closing the door automatically when the person has passed through. Mechanically considered, the door is an excellent piece of work both in design and construction. Judging from its operation as now installed on the *Atlanta*, it appears to admirably fulfill the requirements of a perfect water-tight door installation. We understand that Mr. Bowles's system will probably be exhibited at the Paris Exposition, where, by the way, the valuable Pollok prize is to be awarded for the best marine life-saving device submitted.

Such is the *Atlanta* as she will appear when leaving the navy-yard for her trial trip. The renovation and reconstruction have been so admirably planned and carried out, that except for the fact that she possesses only a partial-armored deck, this vessel will now be well up to the standard of modern cruisers of her class.—*Scientific American.*

H. M. TORPEDO-BOAT DESTROYER VIPER, WITH PARSONS TURBINES.

The *Viper* has been built for the British Navy, her special characteristic being that she is fitted by the Parsons Marine Steam Turbine Company, Limited, of Wallsend-on-Tyne, with the now well-known steam turbine invented by the Hon. Charles Parsons. The vessel is 210 feet long, 21 feet beam, 12 feet 9 inches depth molded, and displaces 350 tons. These dimensions differ little from those of the destroyers fitted with the ordinary reciprocating engines—the displacement is 25 tons more than the heaviest of the 30-knot boats—and it becomes interesting to note the increase in power for each successive addition to speed. The first boats of 26 knots had 3200 indicated horse-power at command, then 27 knots required an increase from 4000 to 4200 indicated horse-power. When 30-knot boats were built, it was found that the power had to be 6000 indicated horse-power; for 32 knots the power was found to be close upon 9000 indicated horse-power, and the turbine-propelled Viper has, it is said, attained her speed of 35½ knots with 11,000 indicated horse-power. In other words, the power for 26 knots was 12½ indicated horse-power per ton of displacement; for 27 knots, 15¼ indicated horse-power per ton; for 30 knots, 20 indicated horse-power per ton; for 32 knots, 24½ indicated horse-power per ton; and for 35 knots, 31½ indicated horse-power per ton. It will be noted that the increment in power, just over 30 knots, is not so great as under and over that speed, and that between 32 and 35 knots it shows a quick upward movement. The other vessels make 400 revolutions, the Viper's engines nearly three times this; and thus it was necessary, instead of having only two propellers, to fit eight on four shafts, so as to secure the necessary forward thrust and the advantages of high rotary speed.

There are two shafts on each side of the center line of the ship, with two sets of compound steam turbines. The arrangement on both starboard and port sides is that the high-pressure turbine drives the outer, and the low-pressure turbine the inner shaft. On the inner shaft a reversing turbine is also fitted; it runs idle when the boat is going ahead, and when it drives the ship sternward, the forward turbines are idle. The speed astern is 15 knots. The screw shafts are carried by brackets as usual, and on each shaft two propellers are mounted, the after having a slightly larger pitch than the forward propeller. There are thus eight propellers. The thrust from the shafts is entirely balanced by the steam acting on the turbines, so that there is little friction. The multiple propellers, and the high rotary speed, with the absence of reciprocating parts, overcomes vibrations which, apart from their wearing effect on the hull and on the personnel, render good gun-practice inaccurate. The weights are as follows:

	Tons.
Boiler-room weights with water in boilers........	100
Engine-room weights with auxiliary gear and water in condensers	52
Weight of propellers, shafting, &c................	7
Total............................	160

The boilers are of the Yarrow type, and the auxiliary machinery and condensers are of the ordinary type. The hull and all fittings are of the usual design. The official Admiralty trials will be looked forward to with great interest.—*Engineering.*

BOILER ARRANGEMENTS OF RECENT BRITISH AND FOREIGN CRUISERS.*

By F. T. Marshall, Member.

Dealing with the question of boiler-room work, we find that, on the basis of the natural-draft power, the two water-tube types are substantially lighter than the cylindrical type, the Yarrow type being the lightest. On the basis of the maximum power the advantage of the Yarrow type in this respect is enormous, whereas the Belleville type is not materially lighter than the cylindrical, owing to the fact that it is not forced. Thus, on a given weight, the Belleville type will develop, with natural draft and for long periods, approximately the same power that the cylindrical type will develop for short periods of a few hours under extreme forced draft. Also, on the same weight, the Yarrow type will develop 14 per cent more than the Belleville for long periods, and 78 per cent more for short periods. Again, comparing the Yarrow with the cylindrical, it is seen that it will develop 50 per cent more power for long periods, and 65 per cent more for short periods, on a given weight.

These comparisons are based upon total boiler-room weights, including water in boilers plus water in the feed-tanks, and also such fittings as reducing-valves, separators, etc., which form an intrinsic part of the boiler systems. The separate weights of boilers and funnels, water, and boiler-room accessories are also given, and it may be noticed how relatively high the weight of accessories is in the case of the Belleville type, owing to the numerous special fittings which form part of this system.

Forced Draft.

A crucial point in the above comparisons of space occupied and weight is the question of how far forced draft can safely be used in the usual exigencies of service, or even in the extreme case of war. As to the Yarrow boiler, the writer submits that, as far as the boilers are concerned, this type may safely be forced to an air pressure of, say 2 inches (the maximum employed on the Don Carlos trials) so long as the coal lasts. Working under these conditions is, however, very severe on the personnel of the stoke-holes, and the endurance of the men would probably be found to be the measure of the time during which this power could be maintained.

In the case of the cylindrical boilers a four hours' run is probably as long as these boilers could be worked at the maximum forced-draft power. These boilers have a tendency to suffer in the flame-box seams when long fire-bars are used, and it is only by the use of these long bars that the high powers looked for can be obtained. The tube ends also get choked up, especially if fitted with ferrules, and without ferrules the tubes have a great tendency to leak. It is probable that at the end of four hours the boiler efficiency will be seriously affected, and the power could not longer be maintained. On the other hand, however, the high speed obtained during these four hours might mean the salvation of the ship, and it is unfair to overlook this advantage.

It should be understood that the above remarks do not apply to forced draft applied to cylindrical boilers with moderate length of fire-bar, say

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* Paper read before the Institution of Naval Architects, England.

5 feet 6 inches, and with a heating surface of 2¼ feet per indicated horse-power. Such boilers can be worked at about 17 indicated horse-power per square foot of grate continuously at sea; but their size and weight would preclude their use in the type of vessel considered, as the power obtained would only correspond approximately to the results obtained in the ½-inch air-pressure trials of warships.

RAISING STEAM.

The rapidity with which steam can be raised, and the ready response to sudden demands in variation of power, are two matters of utmost importance in war-vessels, and in both of these the water-tube types show a marked superiority over the cylindrical boiler. The large quantity of water contained in the latter makes it a question of hours to raise steam; and, if this operation is hurried, the boilers are strained to a serious extent, causing leakage. The same course of reasoning applies, though to a less degree, to any sudden and rapid large variation of power.

As to the two water-tube types, in both cases steam can be raised to full pressure in about thirty minutes from lighting fires. In the matter of variation of power there is also little to choose between them; for, although the large grate area of the Belleville type is an advantage, the safety with which the Yarrow type may be suddenly forced compensates for it.

LIABILITY TO DERANGEMENT IN WORKING.

In this respect, apart from the difficulties mentioned under extreme forcing, the cylindrical type is to be preferred. All the arrangements, both of the boiler itself and of its accessories, such as the feed and steam-pipe systems, are simpler than in the water-tube types. The boilers are fewer in number, thus reducing the number of pipes and connections, and the consequent liability to leaky joints, etc. The feeding is also less critical, owing to the large water level. In addition to this, the introduction of salt water, even in considerable quantities, owing to leaky condensers or other causes, has little appreciable effect upon the working of the boilers. Although, to obtain maximum results, these boilers must be in a state of thorough repair and cleanliness, they are still serviceable after considerable neglect such as would render any water-tube type useless.

With regard to the Belleville boilers a grave objection, in the writer's opinion, is the enormous mass of mechanical detail in connection with them. Thousands of joints, all dependent upon extreme accuracy of workmanship, and many of them subject to extreme strain, due to varying temperature, are a pronounced feature in the design of this type. These points have been well met in the methods of manufacture, but most rigid supervision is required to maintain the accuracy necessary. The feeding is also extremely delicate, owing to the small quantity of water contained, and also variable weight of this water at different rates of evaporation. This latter condition necessitates the introduction of the hot-well pumps and large feed-tanks already described. The feed-regulator employed, which certainly works admirably, is, nevertheless, a delicate mechanism, and has to be kept in a high state of efficiency. The number of boilers is also great for the power developed. This large subdivision has the advantage of involving only a small reduction of power, should one boiler become inoperative for any reason; but it certainly causes an enormous addition of important detail, such as feed-pipe and steam-pipe arrangements, all requiring care and attention. The furnace air-pumping engines are also an additional complication, involving many extra fittings. Whether these objections are valid, extended experience alone can show, and it is an unquestionable fact that the vessels fitted with these boilers, especially since the addition of economizers, have passed through most severe trials with consistent success.

Referring to the Yarrow type, the construction in this case is extremely simple. None of the riveted seams are in direct contact with the fire, and the strains due to changes of temperature are not severe on the parts of the boiler under pressure, especially if the outer rows of tubes are curved. The casings are probably the most severely tried part of the boilers, but no trouble need be feared from these, if carefully designed.

The great question about this and other small-tube types is the life of the tubes, owing to their comparative thinness. Any information which any gentleman could give us on this point would be of extreme interest.

The tubes of the Don Carlos, as before stated, are .128 in. and .104 in. thick for the 1⅜-in. and 1⅓-in. tubes respectively. They are galvanized externally only, as is usual for this class of boiler in the British navy. Mr. Yarrow, on the other hand, invariably galvanizes the tubes both internally and externally, but this does not appear to be necessary in the case of a boiler with drowned tubes. It is probable that one cause of wastage on the outside of the tubes is the method of steam-cleaning usually adopted in these boilers. This steam jet leaves the tubes damp, which naturally aggravates any tendency to rust. In the Don Carlos the tube-sweeping arrangement was taken from the compressed-air pipes used in connection with the armament. This gives a perfectly dry-air jet at high pressure, and proved a most efficient cleaner without the above objectionable feature. The feed-system already described has the disadvantage of a large number of pumps, but in all other respects is very simple and unlikely to become deranged. The area of water-level also is large relatively to the quantity of water in the boiler, and this area is naturally the measure of the difficulty of steady feeding.

As to the possibility of working with salt water as make-up feed, our experience has certainly been against it in both the water-tube boilers considered. A serious tendency to prime, except at very low powers, is produced by even a small admixture of sea-water, and anything approaching continuous use would be, in the writer's opinion, most undesirable. This is evidently borne out by experience, as the Admiralty have recently taken special precautions in all their vessels to minimize the risk of salt water entering the boilers through inadvertence, or without the special knowledge of the officers in charge.

FACILITY OF OVERHAUL.

In this respect the Belleville type has a great advantage, viz., the readiness with which complete elements can be taken from the boiler, repaired in the stoke-hole, and replaced. The other parts of the boiler are also of small dimensions, and, in case of a serious accident, the whole boilers can be taken out of the ship through the usual air-casings without disturbing decks, etc., and with very slight derangement of even the minor fittings. The examination of the inside of the tubes, however, involves breaking and remaking a large number of joints.

As to the Yarrow type, the operation of renewing a tube is by no means difficult, although if the defective tube is in the middle of a nest, all the tubes between it and the outer edge of the tube-plate must also be removed. The method adopted is to work the tubes from hole to hole alternately between the two tube-plates until the outer edge is reached. If, however, time is of importance, the tube ends can be plugged and steam raised again rapidly without any injury to the structure. The inside of the tubes can be readily seen through and cleaned, owing to their being straight. This examination is merely a question of minutes, and thus is likely to be more frequently made than if considerable time and trouble were needed. It also involves the breaking of no joints, except the manhole doors. The outsides of the tubes are certainly not easily examined, and it is wise from time to time to remove a tube here and there to judge of the condition of the remainder. In the case of a serious accident, or serious neglect, necessitating the retubing of a large portion of the boiler, the process would doubtless be slow. It is not a contingency likely to arise, and in any boiler would necessarily be a dockyard repair. Referring to the cylindrical boiler, the capabilities of this type for ordinary examination and overhaul are well known. For heavy repairs, however, such as renewing a furnace or flame-box, the process is both tedious and costly, and in the extreme case of removing a boiler from the ship the whole of the protective deck and superstructure in way of the boilers has to be removed.

STEAM PRESSURE.

With the water-tube types, the pressure of 300 pounds per square inch is now customary. Such pressures are not practicable, except with water-tube boilers, without enormous increase of boiler weight, and they have the advantage of enabling smaller engines to develop the necessary powers, with the attendant advantage of relative economy at low powers. In cylindrical boilers the best balance of weight, power, and space economy appears to be obtained by using about 155 pounds steam-pressure. The additional economy in the engines, by using such higher pressures as are possible with these boilers, is not sufficient to justify the additional weight of boiler due to such higher pressures in vessels in which coal-consumption is to some extent of secondary importance.

GENERAL CONCLUSION.

The comparisons made appear to lead to the following general conclusions in the case of the three types of boiler considered, starting on the basis of equal space occupied:

The Belleville type is well adapted for maintaining high continuous sea speeds for long periods, and is very economical at high powers. It is comparatively light and well arranged for cleaning and overhaul. Steam can be raised quickly, and large variations in power made readily. It cannot, however, be forced, and has also the objection of great complication of detail and accessories, with consequent liability to derangement.

The Yarrow type is hardly so well adapted for continuous steaming at relatively high powers, and is not so economical under such circumstances. It can, however, be forced to almost any extent with safety, and much higher speeds obtained for considerable periods. Steam can be raised quickly, and large variations in power made readily. It is extremely light, and, being simple in detail, has small liability of derangement. Cleaning and overhaul are fairly easy, but the examination of the outside of the tubes is difficult.

COMPARISONS OF BELLEVILLE, YARROW, AND CYLINDRICAL BOILERS.

Name of Ship	Andromeda.	Hermes.	Don Carlos I.	Hai Chi.	Æolus.	Pallas.
Number and type of boiler fitted	30 Belleville.	18 Belleville.	12 Yarrow.	8 cylindrical, 4 D.-E. and 4 S.-E.	5 cylindrical, 3 D.-E. and 2 S.-E.	4 cylindrical D.-E.
Steam pressure, in pounds, per square inch	300	300	300	155	155	155
I. H. P. with natural draft*	16,500	10,000	8,000	12,000	7,000	5,000
" with forced draft	......	......	12,500	17,000	9,000	7,500
Total heating surface, in square feet	40,140	24,050	32,004	27,558	15,947	11,040
Heating surface, per I. H. P., natural draft	2.44	2.405	4.0	2.3	2.28	2.2
" " " " forced draft	......	......	2.56	1.62	1.77	1.475
Total grate area, in square feet	1,430	750	587	940	560	406
Length of fire-bars	6 ft. 3 in.	6 ft. 3 in.	7 ft. 3 in.	7 ft. 1½ in.	7 ft.	7 ft. 3 in.
I. H. P. per square foot of grate, natural draft	11.47	13.33	13.6	12.78	12.5	12.3
" " " " forced draft	......	......	21.3	18.1	16.05	18.4
Total boiler-room area, in square feet	4,925	3,100	2,440	3,470	2,230	1,900 †
I. H. P. per square foot of boiler-room area, natural draft	3.35	3.22	3.28	3.46	3.14	2.63
I. H. P. per square foot of boiler-room area, forced draft	......	......	5.12	4.9	4.03	3.94
Heating surface, per square foot of boiler-room area	8.15	7.77	13.1	7.94	7.16	5.82
Grate area per square foot of boiler-room area	.292	.242	.24	.276	.251	.214
" " " on basis 6-ft. 3-in. bars	.292	.242	.207	.242	.22	.185
Total weight of boilers, uptakes and funnels, in tons.	559	342	217	447	270	174
" " of water in boilers, in tons	43	30	30	197	103	82
" " of pumps, pipes, connections, water in feed tanks, etc., in tons	168	100	82	97	55	41
Total weight in boiler-rooms, in tons	770	472	329	741	428	297
Weight in boiler-rooms in pounds, per I. H. P., natural draft	104	105.5	92.2	138	157	133
Weight in boiler-rooms in pounds, per I. H. P., forced draft	......	......	59	97.4	106.3	89
I. H. P. per ton of boiler-room w'gt, natural draft	21.4	21.19	24.5	16.2	16.4	16.8
" " " " " forced draft	......	......	38.0	22.9	21.1	25.2

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* Natural draft here implies the usual Admiralty conditions, in which an air pressure of ½ in. of water column is permitted.

† Boiler-rooms very large in this vessel.

The cylindrical type is about equal to the Yarrow for continuous high-power steaming, though probably slightly less economical. At low powers, however, it is very economical. It can be moderately forced with safety, and is well adapted for ordinary cleaning and overhaul. All its arrangements are extremely simple and unlikely to become deranged. Sea water can be used in it with safety. It is, however, heavy; steam can only be raised very slowly, and large variations in power cannot be made quickly.

The foregoing conclusions, the writer submits, point to the fact that the boiler question is one which must be dealt with in its relation not only to each individual class of ship, but to each individual service. The adoption of any type will depend upon what particular qualities are most desirable for the boilers to possess to meet the special work which the vessel is designed to do. The general naval policy of any Power will thus have a direct bearing upon the question of what type of boiler is preferable for a given ship.

In conclusion it may be added that the three types considered are given merely as a comparison of actual examples of typical boilers, and are not put forward in any spirit of comparison with other types of boiler or other systems of working.—*Marine Engineering.*

COALING VESSELS AT SEA.*

Bell's requirement.—Lieutenant Bells says, "Any satisfactory plan of coaling at sea must satisfy the following requirements:—(1) Rapidity. (2) Safety. (3) Ability for the ships engaged in the operation to proceed with the minimum diminution of speed. These three requirements are absolutely essential to the success of any plan, but there are others of no little importance. (4) Necessity of keeping coal dry. (5) Minimum of labor to be employed. (6) Little cost for material necessitated."

Lieutenant Bell's plan.—In the plan suggested by Lieutenant Bell he first took the collier in tow of the warship, and then added an inclined and elevated cable attached low down to the after mast of the warship and to the top of the foremast of the collier. On this elevated line a truck or carriage was employed capable of running along this line. Two ropes are used, one fastened to the rear, and one to the front of this truck, leading the one to the warship and the other to the collier, so that the bags of coal secured to the truck can be drawn over to the warship, and the empty truck hauled back to the collier. The hawsers he used crossed from the "stern pipes of the ship of war to the bow ports, hawse ports, or other convenient places of the coal ship." He proposed to carry five bags at a time, carrying about 220 pounds of coal per bag. The bags were to be hoisted, by some arrangement, not shown, from the deck of the collier, to the suspended cable, and there attached by a man stationed on the foreyard for that purpose. With this plan he proposed to satisfy all the requirements which he had laid out—namely, rapidity, safety, etc. While he refers to the fact that his appliance costs but a trifle, he adds the following: "I would at the same time insist that no expense should be considered too great to carry out this most important,

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* A paper by Mr. Spencer Miller, presented at the annual meeting of the American Society of Naval Architects and Marine Engineers.

I may say all-important, operation in those cases where it may be essential to the success or safety of any ship or ships of the navy, or any expedition they may be engaged in."

*Discussion of Lieutenant Bell's plan.**—The discussion that followed was properly very severe on Lieutenant Bell's plan, for, as it will be observed, there were no means provided for maintaining a uniform tension on this elevated and suspended wire, and if the vessels so rigged were pitching ever so little, either one of two things would occur, and probably both after a short time. By the ships pitching towards each other the coal bags would be likely to be dropped into the sea, and by pitching away from each other, either the foremast of the collier would be unshipped or the suspended cable snapped. Commander Campbell said: "I do not agree with him, but I admire his principle, and I sincerely hope this paper may help to give another blow to the 'happy-go-lucky system,' and assist us in bringing about that systematic organization of every detail for which the navy is now crying with one voice, and which is now happily receiving the special attention of our rulers." Lieutenant Tupper said, among other things: "I think the practice of coaling ships, both at sea and in harbor, ought to be made just as much a drill and evolution as are many other operations which have to be performed." The chairman of the meeting, Admiral Boys, said in relation to Bell's plan: "But if those ships should get in any seaway whatever, the operation, I believe, must break down. As to blockading, if we are to blockade, the practice of coaling at sea by boats or otherwise will occasionally be adopted."

The Low plan.—The Hon. Philip B. Low secured a patent, July 10th, 1893, on a plan practically the same as that of Lieutenant Bell, described in his paper six years earlier, but with the addition of a counterweight secured to the end of an elevated carrying cable. This counterweight was arranged to maintain a constant tension, and consequently a constant deflection on the suspended cable, regardless of the motion of the ships. The use of a counterweight to maintain a constant tension on a suspended wire rope has successfully been employed in wire-rope tramways. His plan was tested by the Navy Department in October, 1893. The test took place on board the U. S. S. San Francisco and the U. S. S. Kearsarge. The distance from the shears of the cruisers to the upright poles on the collier was about 235 feet, so that the distance between the vessels was something less than 200 feet. The transporting cable, or the transmission wire, as the inventor called it, was secured to the deck of the San Francisco, supported by a pair of shear poles at the stern, then run on an incline to a gin block near the foremast of the Kearsarge, which played the part of the collier, at an elevation of about 32 feet above the point of suspension on the San Francisco. This gave an air-line inclination from the points of support of about 8 degrees to the horizontal. After the cable was rendered about the gin block it was bent backwards, and on the end was secured a counterweight about 1600 pounds weight. The bags of coal weighed nearly 200 pounds, and the time required to travel from the pole head on the collier to the shear pole on warship was about 14 seconds. The time of hoisting and sending over ten bags of coal was about 20 minutes, giving the rate of about 2 to 2⅔ tons per hour. The Board of Naval Officers were instructed to report upon the trial, and their official report was that in rough weather the apparatus would not be of great value in transferring coal from one vessel to another. The apparatus was reported to have worked well; but as the sea was calm, it was impossible to tell what would have been the effect in a moderate sea. As the sea becomes heavier, the distance between ships would have to be increased for safety, and there would have to be a corresponding increase in the height of the gin block, in order that a proper inclination could be given to the connecting rope. Presuming that the distance between ships be increased to 300 feet, the same angle of inclination preserved, and the same height of shear poles on the warship, then the gin block on the collier would have to be located 70 feet above the deck of the collier. Seventy feet above the deck of the collier would take one to the truck of the foremast of the U. S. S. collier Saturn. It is clear that to attempt to attach bags of coal at such a height as that above the deck would be difficult, if not impracticable, especially in a rolling sea. Even then the capacity, whatever it might have been at 200 feet, must be something less at 300 feet distance between the ships. In order, therefore, to increase the capacity of this device, it would be necessary to increase the load; but as it will be noticed that with a 200-pound load a 1600-pound counterweight was employed, a 400-pound load would require a 3200-pound counterweight, and a 600-pound load a 4800-pound counterweight, and so on. The element of danger to the ship in carrying any such counterweight would seem to need consideration. If the tow-line should snap, this weight would be pulled up to the gin block, and then something would give away, and the dropping counterweight would do great damage.

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* Meeting of Royal United Service Institution, 1883.

Difficulties of coaling at sea during the Spanish-American war of 1898.—Touching upon the difficulties which were experienced by the United States vessels during the Spanish-American war, the author quotes some paragraphs which appeared in the daily press while the conflict was being waged. The *Commercial Advertiser*, On June 26th, 1898, published a diary of their correspondent located on board the United States battleship Iowa, and only that part is quoted from which has reference to the coaling problem:

"June 7th, 1898. . . . The collier Justine is alongside, and we started in coaling. The Justine has not the coaling capacity of the Merrimac, but she is a fine steamer, very strongly built. In a seaway this is a great advantage, for though we gave her some pretty hard knocks, no holes were punched in her side. Since she comes right alongside our armor belt, she can be the only sufferer. She is also very convenient to coal from. Working three forward hatches, we are able to take aboard very easily 260 tons before supper time.

"June 8th, 1898. Much to our disappointment we found that we cannot get the Justine again to-day, as she was ordered over to the Brooklyn, and we had to content ourselves with the Sterling, and to our sorrow. We had every fender out possible, big rope fellows, too, that will stand any amount of knocking, but no sooner had the Sterling come alongside than she came up heavily against our ash-chute and opened a hole in her side. There was nothing to do but send the carpenter's gang aboard and shove her off for repairs. Every one is disgusted with the Sterling for having sides like paper.

"June 11th, 1898. We tried to coal again from the Justine to-day. Made all preparations, and even started sending the coal aboard, but, before we got more than a dozen bags on, the ships knocked together again so badly that we had to cast the collier off and give it up again.

It is most aggravating, for now we must clean up the ship, only to start in coaling again on Monday."

Thus it will be seen that coaling was begun on the 7th, and on the 8th, 9th, 10th, and 11th, practically no coaling was accomplished, although each and every day they needed coal, and were desirous of having it. It may be interesting to know that this same collier Justine, after discharging a single cargo of coal, was returned to Newport News and laid up a long time for repairs, the bill for which exceeded $4000.

It is generally conceded that Cervera's defeat was due directly to the fact of being out of coal and provisions, and he thereby sought the harbor of Santiago de Cuba to fill his bunkers. It is also a fact that had he been as speedy about coaling after he had arrived, he probably could have escaped from the harbor, because the American vessels were also short of coal, as will appear from the messages exchanged between Admiral Sampson and Commodore Schley and the Navy Department, as they appeared in the report of Captain Crowninshield, Chief of Bureau of Navigation. The following message was sent from Commodore Schley to Admiral Sampson: "Arrived May 21st off Cienfuegos. . . . Expect difficulty here will be to coal from colliers in constant heavy swell. Other problem easy compared with this one so far from the base." On the same day Admiral Sampson received this despatch from Commodore Schley, dated May 24th: "Coaling off Cienfuegos is very uncertain. Having ascertained that the Spanish fleet is not here, I will move eastward to-morrow, communicating with you from Nicholas Mole; on account of short coal supply in ships, cannot blockade them if in Santiago. I shall proceed to-morrow, 25th, for Santiago, being embarrassed, however, by Texas' short coal supply and her inability to coal in open sea. I shall not be able to remain off that port on account of general short coal supply of squadron, so will proceed to the vicinity of Nicholas Mole, where the water is smooth, and I can coal Texas and other ships with what coal may remain in collier." So much has been said about this matter, it is only necessary to say that had Commodore Schley been in possession of colliers fitted to coal at sea, especially during his journey from Cienfuegos to Santiago, there would have been no occasion for his leaving Santiago unguarded a day after his arrival.

French experiments.—While the Spanish-American war was in progress the French were experimenting on this problem of coaling at sea. The Paris correspondent of the London *Times*, on July 28th, said, in reference to the experiments in coaling with the Temperley transporter, as follows: "The second interesting point in these manœuvres has been the attempt to coal at sea. This experiment, if successful, would necessarily have led to a considerable innovation in naval plans, for it would have induced the authorities to send out under the protection of men-of-war floating depots which would follow the fleets destined to fight in distant waters, and to supply them with coal. The Japon, a collier, 3000 tons, furnished with a crane—Temperley transporter—while steaming six knots in a rough sea and strong breeze, succeeded in coaling the Marceau and La Touche Treville with 200 tons of coal. It was a successful beginning, but the operation was not continued as long as desired, it being interrupted in the case of the Marceau by way of precaution, and in the case of La Touche Treville on account of an accident to the Japon, which had to return to Toulon for repairs." This problem does not seem to have been fully solved, as proved by the damage sustained by the Japon. The French Admiralty "is confident of a decisive result, for it has just decided that the Japon is to remain permanently attached to the Mediterranean reserve squadron. This solution will naturally have important consequences, one of the first being eventually the complete revictualing of ships in motion, or at any rate out at sea. There is no doubt, indeed, that, the question being thus raised for all navies of the world, it will be solved. We may even go further. If all the nations could have not merely coaling stations but complete revictualing stations always at hand, victualing on the voyage would be neither necessary nor useful. This, however, is impossible, even for the richest and best equipped powers, especially now-a-days, when colonizing nations may be drawn into action in far distant regions. It may therefore be supposed that the problem to be laid down will be coaling and revictualing in motion." "This is the question now before all the great navies, and as such experiments cannot be made in the dark, it is certain that all nations will almost simultaneously have the necessary apparatus for enabling ships to be supplied at sea, so that they can be sent to the greatest distance without running short, at the moment of combat, of either food or coal."

Coal supply: Vice-Admiral Colomb, R. N.—A number of interesting reviews of the Spanish-American war were made by foreign naval officers. One of the most interesting touching the subject of coal supply was written by the late Vice-Admiral P. H. Colomb., R. N., in *Cassier's Magazine*, published August, 1898, entitled "Coal Supply, Speed, Guns, and Torpedoes in Marine Naval War." Among other things under the head of coal supply, Vice-Admiral Colomb said: "We get speed and certainty for voyages made under steam, and the full advantages are reaped in peace time, because coal supply can be exactly arranged for and calculated according to the work required of it, for that can be known, but for the warships in war no such special arrangements and calculations are possible. Coal supply can be treated only generally before war breaks out. No one can say beforehand whether it has been advantageously or economically allotted."

Becoming interested in this question in 1893, the author proposed at that time to stretch an elevated cable from the stern of the warship to the bow of the collier in tow, one to be securely fastened to the warship and the other end wound around the compensating engine, similar to the steam-towing machine. The load running on this cable was to be conveyed over by an endless rope. It was expected that the compensating engine would keep an equal strain on this elevated line irrespective of the pitch of the vessels so connected. In March, 1898, Lieutenant J. J. Woodward, Naval Constructor, located at Newport News, Va., invited plans and prices on a device containing much the same general ideas. A few weeks later—April—a plan was sent to Mr. Woodward, and he in turn transmitted it, with favorable recommendations, through the Chief Constructor, to the Secretary of the Navy. It was not, however, until August of the same year that any understanding was had with the Navy Department whereby the work of construction could be begun. The plan, considerably modified, was submitted to a Board of Naval Officers, consisting of Rear-Admiral Ramsay, president, Thomas Williamson, chief engineer, and Z. L. Tanner, commander, and they consider the device "feasible in moderate weather." Thereupon the Department contracted with the Lidgerwood Manufacturing Company, of New York City, U. S. A., to have the apparatus installed on board the collier Marcellus. So much time was lost in negotiations, however, that before the work of construction was begun the war came to an end.

The author's experiments.—October 25th, the author performed an experiment in New York harbor with a tug, towing a sloop, using a quarter-sized model. Shear poles were mounted on the tug, and blocks on the mast of the sloop, the distance between points of support being 200 feet. An endless rope was employed, being used in accordance with the plan shown in Fig. 1. A movable sheave in the bight of the cable aft the mast was held taut by a line connecting it with a sea anchor or towing cone dragged in the sea behind the sloop. By this plan it will be observed that the tug towed the sea anchor as well as the sloop, the latter merely supporting the rope as it passed over. A carriage gripped to the upper part and provided with wheels to roll on the lower part served to carry the bags of coal over from sloop to tug. As the experiment was performed in a storm, no photographs were taken. The storm was so severe that the sloop shipped water over the bow, and both boats rolled and pitched very badly. In spite of this, however, the bags of coal were conveyed across the space as though the sea was smooth; the sea anchor serving to perfectly act as a compensator, maintaining a constant tension on the endless conveying cable. If such a plan were adopted, the sea anchor would have to be selected in accordance with the speed of towing; the greater the speed the smaller the cone required.

Description of the Miller Conveyor on the U. S. S. Marcellus.

(1) It is proposed, with this device, for the warship to take the collier in tow, or the collier to tow the warship, leaving the distance between ships about 300 feet; this method of securing boats at sea is recognized as being safe.

(2) The warship to receive the coal will erect a pair of shear poles on its deck, which, secured by guys, will support a sheave wheel and a chute to receive the load.

(3) The collier is provided with a specially contrived engine located aft the foremast, having two winding drums. A steel cable, ¾-inch diameter, leads from one drum to the top of the foremast, over a sheave, thence to the sheave on the warship, back to another sheave on the top of the foremast, thence to the other drum. This engine gives a reciprocating motion to the conveying rope, paying out one part under tension; a carriage secured to one of the parts passes to and from the warship, its load clearing the water intervening.

(4) A carriage of special form is provided with wheels which roll on the lower part to the conveying cable, and grip slightly but sufficiently the upper part of the cable. This carriage will carry bags of coal 700 pounds to 2000 pounds. The load is held by a hook pivoted at the bottom of the carriage, which hook is held by a latch. When the carriage comes in contact with the rubber buffer on the sheave block at the warship, this latch is pressed in, thereby releasing the hook and its load. Should the carriage strike heavily at either terminus the upper part of the cable will slip through the grip and no damage will be done.

(5) As soon as the bags are dropped, the direction of the rope is reversed, and the carriage returned to the collier. During the transit of the load an elevator car descends to the deck, bags of coal placed thereon, suspended from a bale, and elevated again to the stops on the guides, so that when the carriage has returned to the collier, the pointed hook finds its way under the bail or hanger supporting the coal bags. The instant the load is hooked on, the direction of the ropes is again reversed, the

carriage takes its load from the elevator and transfers it across the intervening space to the warship, and drops it again into the chute.

(6) The engine for operating the conveyor is of peculiar construction. It runs practically all the time in one direction, its speed being varied by the use of the throttle. The drum near the foremast is provided with friction mechanism so that it is capable of giving to the rope a tension anywhere from 1000 pounds to 4000 pounds. This drum is operated by a lever. The other drum is of special form, employing two dry metallic surfaces in contact. This drum is adjusted so that it will slip under any strain exceeding, say, 3000 pounds. It may be adjusted while the operation is going on, the tension being increased if the load sags too much, and diminished if the deflection is unnecessarily small. The forward drum will be referred to hereafter as the 4000-pound drum, and the other as the 3000-pound drum. When the engine is running, the tendency of both drums is to draw both parts in, one to the extent of 4000 pounds and

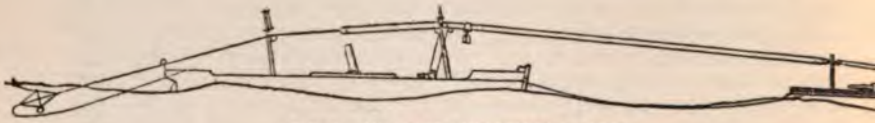


FIG. 1. MILLER'S EXPERIMENTS, 1898.

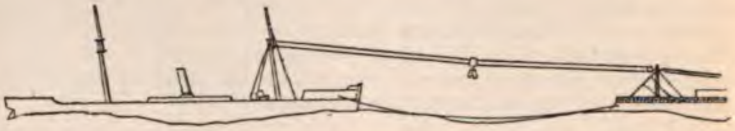


FIG. 2. MILLER CONVEYOR, 1899.

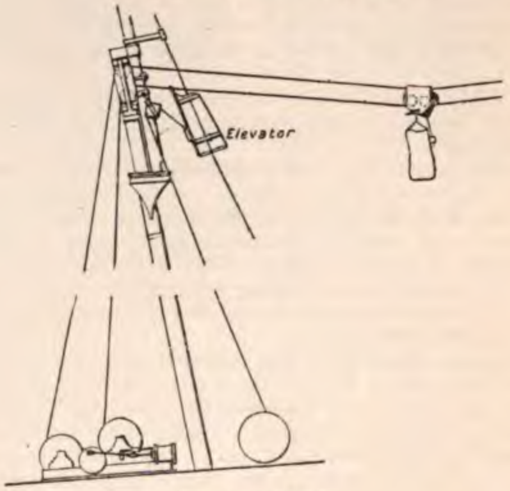


FIG. 3. DETAILS.

the other 3000 pounds. The effect, therefore, is for the 4000-pound drum to prevail and overhaul the 3000-pound resistance, and it is this resistance that sustains the load in its transit between the two boats. Through the co-operation of the two drums the conveying distance between the two boats is compensated for, and a practically uniform tension sustained during the transit of the load. If the points of support on the two ships approach each other—during the transit of the load—the effect will be that the drum pulling 4000 pounds will take up the slack so produced, and the 3000-pound drum will temporarily cease slipping, or at least the slip will be reduced. If now the boats pull apart, the 3000-pound drum will simply slip the faster. All that is necessary, therefore, in the operation of this machine is to see to it that the speed of transit is in excess of double the speed at which the two boats come together.

(7) After the load is dumped at the warship the operator of the engine releases the friction lever on the 4000-pound drum, thus reducing the tension on the lower part to some point considerably below 3000 pounds, whereupon the 3000-pound drum acts to haul in rope, and thus returns the carriage to the collier.

(8) The speed of conveying is about 1000 per minute, consequently the load will be taken from the collier and deposited in the warship in about twenty seconds.

(9) Attention is called to the fact that the total tension on these two parts of rope will never exceed, say 8000 pounds; furthermore, should the ships pull away from each other and the tow line part, the only effect will be to unwind the rope from one of the drums, its end falling into the water, whereupon the other drum will wind in the other end of the rope and recover the carriage attached thereto. The drum used for operating the conveyor also serves to wind up and store the cable when the collier is not coaling at sea.—*The Engineer*.

COALING VESSELS AT SEA.

At the recent meeting of the Society of Naval Architects and Marine Engineers, a paper was read by Spencer Miller on methods of coaling warships at sea, in which the apparatus he had designed was explained. Our readers will recall the abstract of his paper published in the report of the meeting. Since that time further experiments have been carried out by the Navy Department, using this apparatus at sea off Sandy Hook, the collier Marcellus and battleship Massachusetts taking part in the trials. They were at a distance of from 300 to 400 feet apart, depending on the condition of the sea. On the collier there was mounted an engine with two drums or reels; a small wire rope, ¾-inch diameter was led from one drum or reel to a sheave at the top of the foremast and thence across to a sheave mounted above the quarter deck of the warship, returning by a parallel route to another drum or reel. A load carriage of novel design gripped the upper branch of this elevated rope, and was forced to travel by the reciprocating motion of the rope to and from the warship. From the carriage were suspended two bags of coal weighing 840 pounds, and by disengaging gear these were dropped into a canvas chute over the quarter deck of the warship at the rate of one load per minute, or from 20 to 25 tons per hour. The rope was operated by one drum or reel winding in one end of the rope, while the other drum or reel was arranged to wind the rope and also to slip when needed. Thus one drum gave motion to the rope and the other kept the requisite tension in the rope while it was paying out, so that the coal bags were carried with sufficient clearance over the water. The supports for the apparatus were the foremast of the collier and shear poles on the Massachusetts, and these were held by steel guy ropes much stronger than the small wire ropes which carried the loads across. By the use of this conveyor if the boats lurch apart, one rope simply slips to accommodate it, and if the boats come together either one drum or the other winds it in at a speed faster than the ships can approach one another. The invention employs besides the conveying rope, an auxiliary rope known as the sea-anchor line, which is solely employed to prevent the carriage from twisting when returning unloaded from the warship. This sea-anchor line is secured by a lashing or knock-off hook to the warship and passes over a pulley on top of the carriage; from thence it is led through pulleys on the two masts and then astern several hundred feet into the sea. On its end is secured a canvas cone dragging with its mouth towards the warship and known as the sea anchor.—*Marine Engineering.*

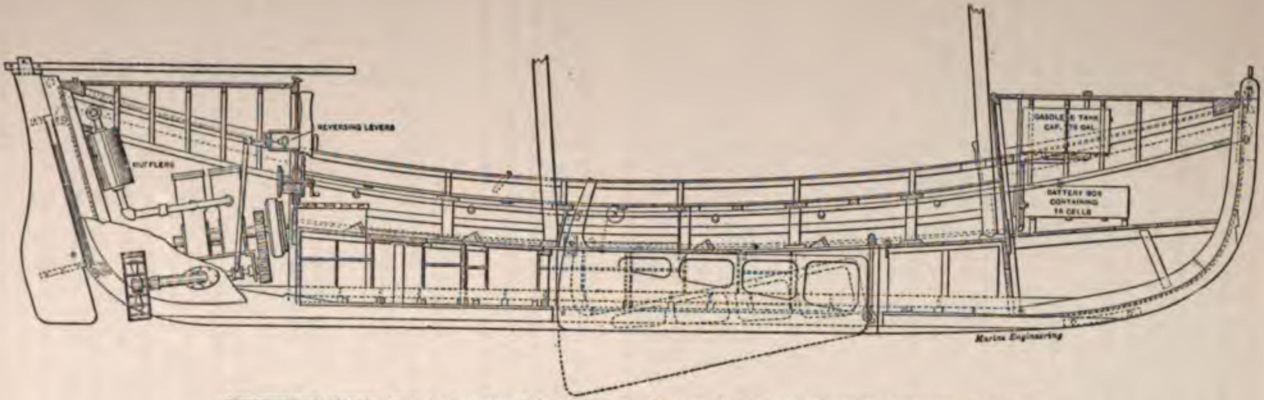
TWIN-SCREW LIFEBOATS FOR THE U. S. LIFE-SAVING SERVICE.

By Lieutenant C. H. McClellan, R. C. S., Asst. Inspector.

There are two principal classes of boats used in the United States Life-Saving Service, the lifeboat and the surfboat. The lifeboat, because of its great weight, 6000 to 10,000 pounds, is located where it can be launched into comparatively smooth water from a cradle, as in the harbors of the Great Lakes, and is propelled by oars and sails, or assisted by a tug boat to the vicinity of the wreck. The surfboat, weighing from 1200 to 1500 pounds, is placed at all of the coast stations, and is easily transported along the coast on specially constructed carriages to a point nearest the wreck, and then launched from the beach. The surfboat is also supplied to all of the lake stations. The lifeboat is propelled by ten oars, pulled double bank, and three sails. The sail plan is small and heavy, as it is mostly used in heavy winds.

If the vessel in distress is a considerable distance from the lifeboat station the assistance of a sea-going tug is usually necessary to tow the lifeboat to the vicinity of the wreck, when the tow line is dropped, and the lifeboat manœuvred to get within reach of the wreck and make the rescue. Usually, if the conditions will permit, the lifeboat is dropped to windward and pulls down to the wreck and takes off the crew, and in the meantime the tug has steamed to leeward of the wreck, where the lifeboat joins her after the rescue. This process is necessary because of the great weight of the lifeboat and the difficulty in pulling her against a wind of any force. It consumes much time, which is augmented in many cases by waiting for the towboat to get up steam, or from there being no tug immediately available.

The necessity for a lifeboat with power has long been recognized, both in this country and in Europe, but because of the peculiar work required of the lifeboat the problem has been difficult of solution. The British



LONGITUDINAL SECTION OF U. S. STANDARD 34-FT. LIFEBOAT, PROPELLED BY TWIN SCREWS DRIVEN BY GASOLENE ENGINE.

Royal Lifeboat Institution has been working on this problem for several years, with doubtful success, having built several steam lifeboats; * but in the opinion of many the mistake has been made of building their boats too large, they being, in fact, seagoing tugs. The lifeboats of the U. S. Service are made self-righting, as they are used in surf which can, and frequently has, capsized them. A boat with steam-power, if capsized and rolled completely over, would have but little assistance from its engine afterwards. Experiments have recently been made by the U. S. Life-Saving Service with a gas engine as the motive power, and with very gratifying results. The Service 34-foot lifeboat was selected, the largest class in use, and in this a 12 H. P. "Superior" gas engine was placed. This engine was selected because of its lightness per horse-power, simplicity of construction, compactness, and its ability to run under adverse conditions. It is also arranged to turn two propellers with one engine.

The engine, with the gears and attachments of the two propeller shafts, is installed wholly within the after air-chamber, the only portion of the machine on the outside being the two reversing levers, the end of the starting shaft, and the oil cups. The parts outside of the air-chamber are in recesses in the bulkhead, out of the reach of ropes or other dangers, as shown in the accompanying drawing. The engine was installed without disturbing the construction of the boat. It was passed through an opening 16 inches by 16 inches, and set up on the inside. The air-chamber is 6 feet long and 6 feet wide at the gunwale of the boat, tapering to a few inches at the keelson and stern-post. The engine weighs 1350 pounds, is of the two-cylinder type, having an explosion every revolution, the spark being produced by sixteen portable rubber-cell batteries. The engine cylinders are 6 inches by 6 inches, and the speed of revolution is 400 turns a minute.

There are two 18-inch propellers, having two reversible blades each, the reversing levers being connected to pulls leading through stuffing-boxes in the bulkhead. The propellers are protected on the outside by suitable cages. The cylinders are lubricated by automatic oil pumps, and all other bearings by cups placed in a recess in the bulkhead, and accessible from the outside.

Air is supplied to the engine through two 2½-inch brass pipes leading from the top of the inside of the air-chamber, down the bulkhead, and opening through it 6 inches from the deck. If the boat should be upset, these openings will be in the air space under the boat, and out of the reach of the water.

Gasoline is stored in the forward air-chamber and as high as the roof will allow, the gasoline being carried to the engine by gravity, dispensing with the pumps and their different parts so apt to become clogged and fail at a critical moment. The tank in the boat under trial has a capacity of 75 gallons, though there is room in the air-chamber to carry a much larger tank if necessary. To prevent the fuel from being cut off from the engine by reason of the extreme pitching of the boat, as might occur in a very heavy surf when the stern is on a high sea, a small reservoir is attached to the engine through which the gasoline flows to the engine. The engine consumes 2 gallons of gasoline an hour when under the full speed of 7½ miles per hour, at an expense of about two cents an hour per horse-power.

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*An illustrated description of a hydraulic propelled lifeboat was published in the issue of January, 1898, of Marine Egineering.

The batteries are sealed, and carried in a drawer fitting into a close case in the forward air-chamber, having its only opening in the bulkhead By this arrangement the batteries must be removed from the air-chamber for any needed attention, thus removing all danger of accident from a spark caused by ignorant handling of the wires.

Provision has been made for cutting off the supply of fuel from the engine in case of a capsize, thus stopping the engine. This is advisable, for without this precaution, if the lifeboat was upset, and the crew thrown into the water, the boat would right almost instantly, and, the engine being in motion, would run away from the crew before they could climb into the boat. Another reason for stopping the engine during an upset is the danger from having the passengers and crew thrown into the water with the two propellers running at a high speed in the vicinity. The self-righting qualities of the lifeboat have not been injured by the addition of the weight of the engine. In the tests made she righted from even trim, bottom up, to even trim, right side up, in 3 seconds.

In these tests the boat attained a speed of 7½ miles an hour over a measured course. She reversed from full speed ahead and had sternway on in 20 seconds. With one propeller going ahead and the other astern, she turned in a circle 50 feet diameter. The boat was tested under sail and power during a gale blowing at the rate of from 28 to 40 miles an hour, as registered at the Weather Bureau. She was taken 5 miles outside of the harbor of Marqette, Mich., and tried under all directions of wind and sea, and behaved as well as could be desired. Under the same conditions of wind, and without the engine, a tugboat's assistance would have been necessary, or several hours consumed in beating the lifeboat out against the wind.

It is the unanimous opinion of the officers of the Service who have witnessed the trials of this boat that the Service would have a very valuable auxiliary by its general adoption.

U. S. S. BAILEY.

The torpedo-boat destroyer Bailey was launched into the Harlem river from the yard of the Gas Engine & Power Co., and Charles L. Seabury & Co., Consolidated, New York City, on December 5. The boat was christened by Miss Florence Beekman Bailey, grand-daughter of the late Rear-Admiral Theodorus Bailey after whom the boat was named. An artistic silver loving-cup is to be presented by the family of Rear-Admiral Bailey, upon which a suitable inscription referring to the services of the Rear-Admiral under Admiral Farragut will be engraved. The Bailey is one of the three boats authorized by act of Congress of March 3, 1897. She has hitherto been classed as a torpedo-boat destroyer, but is now placed in the list of torpedo-boats of the navy. The other two vessels authorized under this act are the Goldsborough, building at Portland, Ore., and the Stringham, which was launched some time ago in Wilmington, Del. The Bailey is of the following dimensions: Length, 205 feet; beam, 19 feet 2 inches; mean draft, 6 feet; displacement, 235 tons. She is fitted with twin screws, driven by triple-expansion engines of the builder's design, which are expected to develop 5600 horse-power. Her estimated trial speed is 30 knots. The armament of the boat will consist of two 18-inch Whitehead torpedo-tubes, and four 6-pounder rapid-fire guns. —*Marine Engineering.*

OUR COAST DEFENSES.

To the Editor of The New York Times:

In your issue of the 5th inst. there appeared an interesting article from the able pen of my friend Captain Zalinski, late of the United States artillery. I have the greatest admiration for his genius and energy, but cannot avoid the feeling that he rides his hobby-horse too hard when he blames his government for not carrying into effect the wild recommendations of the Endicott board of fourteen years ago, entailing on the United States people an expenditure of over £25,000,000 for stationary defenses on the coast line.

The defense of the dockyards is, of course, an absolute necessity for any nation aspiring to greatness by means of sea power, but for such a nation to spend money on coast defense, except in the protection of its naval arsenals, rather than spend the same amount in fighting-ships and sailors is indeed a short-sighted policy.

Moreover, America, being so far removed by simple distance from Europe, is peculiarly invulnerable to any coast attack, except by a more powerful naval power. It is, therefore, evident that the safety of her coasts is best assured by a powerful fleet than by any quantity of harbor and coast defenses.

At the commencement of the recent Spanish war the "uneasiness and even fright felt by the inhabitants of the United States seacoasts" was a curious psychological fact for which there was very little foundation, but which certainly influenced the dispositions of the fleet and the movements of the transports.

Captain Zalinski thinks that the existence of the fortifications recommended by the Endicott board would have prevented any such panicky feeling, and would have given the fleet more freedom of action. As to the former, I would ask whether in time of war the inhabitants of Brighton or Bournemouth (which are entirely open to the sea and unprotected) would not be in a safer position than those who reside in Dover or Sheerness?

The very fact of a place being fortified sanctions an enemy to bombard it; the very fact of a town being unfortified prevents a civilized power from bombarding, if international agreements and humane feelings are followed in a war. Even a selfish motive, viz., the fear of reprisals—would be a most potent factor in preventing any such "hitting below the belt."

Again, the bombardment of coast towns is probably a "game not worth the candle," the damage so caused being usually of less value than the cost of the ammunition expended.

From every point of view it would therefore appear that the best defense of a coast line is a covering fleet, i. e., a fleet strategically placed so that an enemy cannot attack the coast except by pin-pricks, which only exasperate without inflicting any real hurt.

But the fleet itself must have naval arsenals and building-sheds and repairing-shops, and these should be situated ten or twelve miles from the open sea, and the waterway thereto be well defended by forts, guns, and mines.

Land defenses are unnecessary in America (except perhaps across Long Island to cover New York), because no hostile power is likely to be in a position to land forces which could not be immensely outnumbered on the mainland.

From her geographical position America is strategically like a huge island, and has nothing to fear on land, save civil war or rebellion. The whole of her war funds should therefore be concentrated upon her fleet, and on a small but well-organized army for foreign service in her new colonies, with its depots and recruiting centers at home. To spend huge sums on coast defenses in America would be wasteful and detrimental to the services actually required.—J. T. Bucknill, Lieutenant-Colonel (late Royal Engineers), Thornfield, England.

VICKERS' AUTOMATIC 14-POUNDER GUN.

Messrs. Vickers, Sons, and Maxim, Limited, who have recently introduced several important improvements in guns and gun-mounts to increase efficiency, principally in the direction of striking energy and rapidity of fire, have now passed through a series of tests a 14-pounder gun, the breech mechanism of which is practically automatic in its action. This gun has been built for the United States Government, and should it succeed as well in its official trials in America as in the preliminary but searching tests just carried out in this country, there is every probability of its being adopted generally in the United States Navy. The gun itself does not differ materially from the 12-pounder which is doing such good work with the naval brigades in the Boer War, but is larger, more powerful, and has greater rapidity of fire, due to the automatic action in loading and firing and ejecting the cartridge. It has a 3-inch bore, with a total length of 161.95 inches. During the recent trials the gun developed a muzzle velocity of 2650 foot-seconds, and a muzzle energy of 681 foot-tons, with a maximum pressure in the chamber of 16½ tons. This energy, which is the more remarkable, in view of the rapidity of fire—26 rounds per minute—is equal to perforating 10.2 inches of wrought iron, or 7.9 inches of steel plate, according to Gavre's formula, while the gun only weighs 17½ cwt., and its naval mount with shield, just over a ton.

The gun is made of steel, and consists of a strong barrel reinforced by a jacket and a hoop. The chief difference, as compared with the 12-pounder gun, is in the mechanism for closing the breech; the older gun is of the usual type, in which a lever, on being drawn forward, performs the three-fold task of unlocking, rotating the block, and swinging it free of the breech. In this new weapon the recoil is brought into use, as shall be presently explained, the breech being closed by a lock capable of vertical movement, containing mainspring, firing-pin, etc. The gun is without trunnions, and fits into a gun-metal cradle; this cradle is fitted with trunnions, which rest in the cross-head of the mounting of the usual conical form. Two combined hydraulic and spring buffers are attached underneath the cradle, and the piston-rods of these buffers are connected with the rear part of the gun.

Before proceeding to describe details it may be interesting to give a table of the principal dimensions and some of the results obtained on trial:

DIMENSIONS, &C., OF VICKERS' 3-INCH (50 CALIBERS) NAVAL AUTOMATIC GUN.

Diameter of bore	3 inches.
Length of bore	150 "
Total length of gun	161.95 "
Diameter of chamber	3.01 "
Length of chamber	27.76 "
Maximum pressure in chamber	16.5 tons.
Weight of charge	3 lbs. 2.5 oz.
Total weight of gun, including breech mechanism	17 cwt. 2 qr. 20 lb.
Muzzle velocity	2650 foot-seconds.
Muzzle energy	681 foot-tons.
Perforation of wrought-iron plate at muzzle by Gavre formula	10.2 inches.
Perforation of steel plate at muzzle by Gavre formula	7.9 "
Rounds per minute	26
Weight of mounting complete with shield	18 cwt. 0 qr. 21 lb.
Weight of shield	2 cwt. 1 qr. 9 lb.
Angle of elevation	20 degrees.
Angle of depression	15 "

Turning now to the special detail of the gun, the firing and breech mechanism, in rear of the cradle there is a pistol-grip, which contains the trigger, and on the right-hand side there is a detachable lever, by the movement of which the breech-block can be lowered or raised. Situated between the buffers underneath the cradle there is a powerful flat spring, the action of which works the breech mechanism. To prepare the gun for firing its initial round, the breech is opened by the movement of the hand-lever, the handle of which is made to rest in a crutch prepared for its reception at the side of the gun. By the movement of the hand-lever a crank is turned. The action of the crank brings down the breech-block, and compresses the powerful flat spring situated between the buffers. At the same time, the pivot on the crank-arm presses down the cocking-lever, thus pulling the striker to the rear and compressing the mainspring. These parts are then kept in position by the action of the sear. The breech-block, in moving down, strikes the lower extension of the extractor and causes the upper portion to move out from the face of the end of the barrel and brings two small projections over the upper edge of the breech-block, thus preventing it from rising by the reaction of the spring.

In this state the gun is ready for acting automatically. The operator has to slide the cartridge by a smart action into the bore. As it goes forward into the chamber, its rim strikes against the extractor and forces back the projections which prevented the breech-block from rising. This is practically the only hand movement in an otherwise completely automatic device. The flat spring already referred to, then acts and rotates the crank, thus raising the block until the breech is closed. The tail end of the sear is now engaged with the toe of the trigger, and by drawing the trigger-pull to the rear the trigger releases the sear, and the firing-pin is thrown forward by the action of the mainspring, which extends across the gun.

The recoil of the gun in the cradle, upon firing, is controlled by the hydraulic buffers already mentioned, and compresses the powerful springs round the piston-rods. The reaction of these springs at once returns the gun into its original position in the cradle. As the gun returns it so acts upon the breech mechanism as to cause the crank to rotate or fall, and thereby it brings down the breech-block. The extractor is actuated by the fall of the block; it first loosens the cartridge by a slow movement, which, rapidly increasing, finally ejects it to the rear.

The gun is now ready for another round. The cartridge is placed in the gun as already described, when the breech closes and is secured automatically. The rounds are fired by pulling the trigger when required, and, as we have said, 26 rounds may be fired per minute.

The gun is mounted on a cone with cross-head and pivot. The elevation and direction of the gun are controlled by the man laying the gun, who stands with his shoulder pressed against the shoulder-piece, the maximum angle of elevation of the gun being 20 degrees, and of depression 15 degrees. In this way, and with his right hand on the pistol-grip, the gunner has full power over the movements of the gun.—*Engineering.*

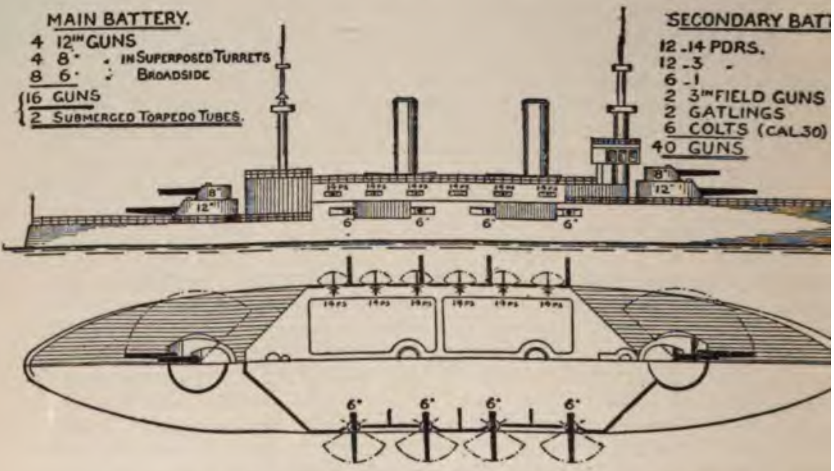
THE ARMAMENT OF OUR LATEST WARSHIPS.

We present illustrations of our latest long-caliber guns, and also of the proposed armaments of the three first-class battleships, New Jersey, Georgia and Pennsylvania, authorized by the last Congress. In the last report of Rear-Admiral O'Neil, Chief of the Bureau of Ordnance, reference was made to the new ordnance which is being constructed for the batteries of future warships. These guns are to use smokeless powder, and develop vastly greater energy, gun for gun, than the old brown-powder guns, which were so largely in use during the war with Spain.

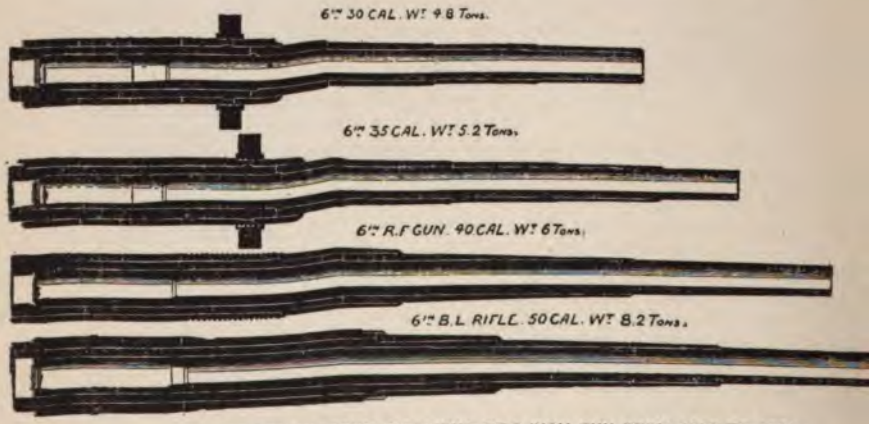
The explanation of the remarkable changes in our navy guns, as shown in the accompanying comparison of various patterns in use during the past fifteen years, is to be found chiefly in the qualities of the powder. The old black powder of the civil war was a quick powder—the charge being almost instantly converted into gas at the instant of firing; the brown powder used in the Spanish war was slower-burning than the black powder, but quicker than the smokeless powder, which burns, for an explosive, at a very slow rate, and gives off enormous volumes of gas. The slow combustion of smokeless powder necessitated a longer bore, to give the powder time to be completely consumed, and it is by the large powder-chamber, big charge, slow combustion and sustained acceleration in the long bore, that the modern long-caliber gun achieves its wonderful results, the projectile of the new 6-inch gun leaving the muzzle with a velocity of 2900 feet per second.

The accompanying diagram shows four patterns, from the 30-caliber 4.8-ton brown-powder gun, as originally carried by our earlier ships, to the new 50-caliber smokeless-powder weapon, which is to be mounted on the New Jersey. The earlier gun of 1883 was 16 feet 3 inches long and fired a 100-pound projectile with a muzzle velocity of 2000 feet per second and a muzzle energy of 2773 foot-tons. Following this came the 35-caliber 5.2-ton gun, which was 18 feet 8 inches long, and gave a muzzle velocity of 2080 foot-seconds and a muzzle energy of 2990 foot-tons. This is the gun originally mounted on the Oregon and class, but since replaced by the 40-caliber rapid-fire gun, which is 21 feet 3 inches long, and has a muzzle velocity of 2150 foot-seconds, and a muzzle energy of 3204 foot-tons if fired with brown powder. The 50-caliber gun is 25 feet long, and when using the new smokeless powder it will develop a muzzle velocity of 2900 foot-seconds and a muzzle energy of 5838 foot-tons, which is more than double that of the earlier, 30-caliber 6-inch brown-pow guns of the Boston and Atlanta.

A study of the diagrams shows that the construction of our guns been greatly simplified by the reduction of the total number of parts which they are composed. The 30-caliber gun consisted of twelve se



ARMAMENT AND ⅔ AMMUNITION 951 TONS—7.03 PER CENT OF 13,500 TONS.


6" 30 CAL. WT. 4.8 Tons.
6" 35 CAL. WT. 5.2 Tons.
6" R.F GUN. 40 CAL. WT. 6 Tons.
6" B.L. RIFLE. 50 CAL. WT. 8.2 Tons.

COMPARISON OF FOUR PATTERNS OF 6-INCH GUN FROM 1883 TO 1899.

rate pieces, whereas the new 50-caliber piece, although weighing nearl twice as much, contains only half that number. The difference is du chiefly to the improvements which have taken place in the manufactur of gun-steel, assisted by the experience which has been gained in th assembling of built-up guns. The Ordnance Bureau of the navy has al ways claimed that it could build as efficient a gun on the built-up or hooped system as could be secured under the wire-wound system, which finds great favor in the British navy; and the behavior of our guns, coupled with the high ballistic results achieved with the latest gun, proves that their confidence was not misplaced.

The built-up gun of 1883 consisted of an inner tube extending from breech to muzzle; a jacket and a set of chase-hoops shrunk on over the tube; and a set of jacket-hoops shrunk on over the jacket, while over these was a ring carrying the trunnions. In the 40-caliber gun, the many chase-hoops have given place to one long hoop or two, while in the 50-caliber weapon the construction is simplified to an inner tube, a single, long jacket and three jacket-hoops. The substitution of a long jacket and a few long hoops for the many short hoops of the 30-caliber gun not only cheapens construction but adds greatly to the transverse strength of the piece.

NAVAL GUNS (MODELS OF 1899).—PERFORATION OF FACE-HARDENED ARMOR WITH SMOKELESS POWDER AND UNCAPPED* PROJECTILES.

Caliber.	Length in Calibers.	Weight in Tons.	Projectile in Pounds.	Muzzle velocity. Foot-seconds.	Muzzle energy. Foot-tons.	Perforation at muzzle, Harveyed nickel-steel in Ins.	Perforation at muzzle, Krupp armor in Inches.	Remaining velocity at 3,000 yards. Foot-seconds.	Perforation at 3,000 yards of Harvey armor in Inches.	Perforation at 3,000 yards. Krupp armor in Inches.
3-inch	50	0.87	14	3,000	874	4.19	3.35	1,401	1.52	1.22
4-inch	50	2.56	32	3,000	1,999	6.11	4.90	1,690	2.85	2.28
5-inch	50	4.46	60	2,900	3,503	7.51	6.01	1,771	3.89	3.11
6-inch	50	8.0	100	2,900	5,838	9.35	7.71	1,893	5.30	4.24
7-inch †	..	...	...	....	.....	.....	.....	.....	.....	....
8-inch	45	18.0	250	2,800	13,602	13.57	10.66	2,068	9.06	6.61
10-inch	40	33.4	500	2,800	27,204	18.57	14.86	2,209	13.53	10.82
12-inch	40	52.0	850	2,800	46,246	23.42	18.74	2,291	17.92	14.34

* With capped projectiles an increased thickness of from 15 to 20 per cent can be perforated.

† Design not yet completed.

The accompanying table shows the ballistics of the new naval guns (1899 model). They are all built according to the improved principles shown in the 6-inch 50-caliber gun, and it is safe to say that as they stand on paper the results are generally equal, if not superior, to those obtained in foreign navies. The 14-pounder, 3-inch gun will form a conspicuous feature in the armament of our future ships. While by its rapidity of fire it will be suited, like the 6-pounder which it displaces, to repelling torpedo-boat attack, its power and range will render it very effective against the unarmored and lightly armored portions of an enemy's ship. The 4-inch gun will be mounted on our gunboats, while the 5-inch and 6-inch guns (chiefly the latter) will be used in the secondary batteries of our warships and cruisers. The 8-inch, and possibly the 10-inch, will be used for the main battery of our cruisers, and the 12-inch weapon will be the main fighting element of our battleships, although, if we follow the latest trend abroad, we may discard the 12-inch in favor of the 10-inch gun. The 12-inch gun is the most powerful weapon of its caliber afloat to-day, its muzzle energy of 46,246 foot-tons being only surpassed by the 16- and 17-inch Armstrong guns of the British and Italian navies, which have a muzzle energy of 54,000 and 55,000 foot-tons. The penetration of our gun, however, is considerably greater.

The accompanying diagram represents proposed design for arming the 13,500-ton battleships of the New Jersey class, the guns to be of the new 1899 model. It is drawn up by the Bureau of Ordnance, and the amount of weight apportioned to armament is based upon the design of the Maine, in which the weight of armament and ⅔ ammunition was 1100 tons, or 8.8 per cent of the trial displacement of 12,500 tons. The design calls for the superposed turret, and is really an improved Kearsarge, the improvements consisting of 2 knots more speed, a lofty spar-deck, and the substitution of eight 6-inch, twelve 3-inch guns and twelve 3-pounders for fifteen 5-inch and twenty 6-pounders—a great increase in fighting qualities, especially if the up-to-date character of the guns is borne in mind.

This design is most powerful, and if the gunnery trials of the Kearsarge are satisfactory, it is likely to be adopted.

An excellent feature in these ships is the recessed gun-ports of the secondary battery, which allow the long 50-caliber guns to be swung round, muzzle to muzzle, against the ship's side, when they are not in use. This is particularly desirable when the vessels are in harbor, or moored at a dock, the long projecting chase of a modern rifle being liable to injury from passing vessels or from cranes or other obstructions at a dockyard.—*Scientific American.*

THE NEW SMOKELESS-POWDER GUNS OF THE UNITED STATES NAVY.

If one were asked to name the most important among the elements which go to make up the modern fighting-ship, preference would have to be given to the armament; for it is certain that, whatever else a fighting-ship may or may not have, she must carry guns, and plenty of them, if she is to be true to her name. The supremacy of the gun in modern warfare was suggested, if not proved, by the excellent results obtained with our extemporized warships in the way of converted merchant steamers, yachts, and tugs, which rendered such a good account of themselves in the Spanish war. Moreover, if our guns are to be fully effective against an enemy whose ability to manœuvre his ships and handle his guns is supposedly equal to our own, there must be no deficiency on our side as far as the weapons themselves are concerned; they must be able to shoot as fast, as far, and as true.

The Bureau of Ordnance of the United States Navy is to be congratulated on the fact that it has always maintained the ordnance which is carried by our ships at the same high level, if not somewhat in advance, of the efficiency of the ships themselves. In the days of brown, smoke-producing powder, the guns of the United States Navy were fully equal

TABLE I.

ELEMENTS OF NAVAL GUNS, GIVING PERFORATION OF FACE-HARDENED ARMOR, AT RANGES UP TO 3,000 YARDS, WITH SMOKELESS POWDER AND UNCAPPED ARMOR-PIERCING PROJECTILES, AT NORMAL IMPACT.

Calibers of guns.	Length.	Weight.	Weight of projectile.	Muzzle velocity.	Muzzle energy.	Perforation at muzzle, Harveyed nickel-steel.	Perforation at muzzle, Krupp armor.	Remaining velocity at 1,000 yards.	Remaining velocity at 3,000 yards.	Perforation at 3,000 yards of Harveyed nickel-steel.	Perforation at 3,000 yards of Krupp armor.
	Calibers.	Tons.	Pounds.	Foot-secs.	Foot-tons.	Inches.	Inches.	Foot-secs.	Foot-secs.	Inches.	Inches.
4-inch ..	40	1.5	33	2,200	1,107	4.05	3.24	1,817	1,245	1.88	1.50
5-inch ..	40	3.1	50	2,650	2,434	5.90	4.72	2,175	1,466	2.68	2.14
6-inch ..	40	6.0	100	2,550	4,507	7.88	6.30	2,212	1,665	4.46	3.65
8-inch ..	35	13.1	250	2,300	9,168	10.44	8.35	2,079	1,698	6.97	5.58
10-inch ..	30	25.7	500	2,200	16,775	13.46	10.77	2,033	1,736	9.81	7.85
12-inch ..	35	45.2	850	2,300	31,170	18.02	14.42	2,151	1,882	13.79	11.03
13-inch ..	35	60.5	1,100	2,300	40,338	20.28	16.22	2,164	1,917	15.91	12.73

NOTE.—With capped projectiles an increased thickness of from 15 to 20 per cent may be perforated.

TABLE II.

TYPES OF NAVAL GUNS (MODELS OF 1899), GIVING PERFORATION OF FACE-HARDENED ARMOR, AT RANGES UP TO 3,000 YARDS, WITH SMOKELESS POWDER AND UNCAPPED ARMOR-PIERCING PROJECTILES, AT NORMAL IMPACT.

Calibers of guns.	Length.	Weight.	Weight of projectile.	Muzzle velocity.	Muzzle energy.	Perforation at muzzle, Harveyed nickel-steel.	Perforation at muzzle, Krupp armor.	Remaining velocity at 1,000 yards.	Remaining velocity at 3,000 yards.	Perforation at 3,000 yards of Harveyed nickel-steel.	Perforation at 3,000 yards of Krupp armor.
	Calibers.	Tons.	Pounds.	Foot-secs.	Foot-tons.	Inches.	Inches.	Foot-secs.	Foot-secs.	Inches.	Inches.
3-inch ..	50	0.87	14	3,000	874	4.19	3.35	2,328	1,401	1.52	1.22
4-inch ..	50	2.56	32	3,000	1,999	6.12	4.90	2,477	1,690	2.85	2.28
5-inch ..	50	4.46	60	2,900	3,503	7.51	6.01	2,460	1,771	3.89	3.11
6-inch ..	50	8.00	100	2,900	5,838	9.35	7.71	2,516	1,893	5.30	4.24
8-inch ..	45	18.00	250	2,800	13,602	13.57	10.66	2,531	2,068	9.06	6.61
10-inch ..	40	33.40	500	2,800	27,204	18.57	14.86	2,587	2,209	13.53	10.82
12-inch ..	40	52.00	850	2,800	46,246	23.42	18.74	2,619	2,291	17.92	14.34

NOTE.—With capped projectiles an increased thickness of from 15 to 20 per cent may be perforated.

to those in use abroad; and the weapons which have been designed and are now being manufactured at Washington to meet the requirements of the new smokeless powder, will be superior to those which are mounted in foreign navies; thus placing us for the first time in the lead in the matter of ordnance.

By the courtesy of Rear-Admiral O'Neil, we are enabled to present the two accompanying tables showing the ballistic qualities, both of our old guns built in the days of brown powder, and of the new guns of exceptionally long caliber which have been constructed specially to meet the requirements of smokeless powder. The guns given in Table I represent the patterns built between 1883 and 1888, before the era of smokeless powder, when the brown powder was the only kind used in our navy. It will be seen that the length of the guns ranged from 30 calibers in the 10-inch to 40 calibers in the 4-, 5- and 6-inch guns. Comparing these with guns of the same caliber in Table II, it will be seen that the smaller guns have been raised from 40 to 50 calibers in length, and the larger ones from 30 to 35 up to 40 and 45 calibers. The lengthening of the guns is due to the difference in the two powders, the brown being quicker-burning (the charge taking less time to be converted into gas and therefore requiring less length of bore to develop its full accelerating energy upon the shell), the smokeless powder, on the other hand, being what is known as a slow-burning powder, and calling for greater length of bore in order to enable the combustion of the powder to be completed before the shell leaves the muzzle. It will be noticed that though the guns given in Table I were built for the use of brown powder, the ballistic data are worked out for charges of smokeless powder, the intention being that in the future only this kind of powder shall be used in our navy.

A comparison of velocities and energies achieved respectively by the old and new patterns of the guns shows the improved ballistics resulting from the large powder-chamber and great length of bore which characterizes the new type. Thus the 50-caliber 4-inch gun has a muzzle velocity of 3000 foot-seconds as against 2200 foot-seconds for the 40-caliber guns. The velocity of the 10-inch guns mounts from 2200 foot-seconds to 2800 foot-seconds, and that of the 12-inch from 2300 to 2800 foot-seconds, the increase in the muzzle energy in each case being in proportion. It is interesting, moreover, to compare the 35-caliber 12-inch gun firing smokeless powder with the same gun when firing the old brown powder. In the former case the muzzle energy was 25,990 foot-tons; with smokeless powder this same gun shows a muzzle energy of 31,170 foot-tons, while the new 40-caliber 12-inch gun with its larger powder-chamber shows a muzzle energy of 46,246 foot-tons, which, by the way, is 13,000 foot-tons greater than that of the 13-inch gun when firing brown powder, and 6000 foot-tons greater than the same gun when firing smokeless powder.

The new guns are to be fitted with an improved type of breech-mechanism, invented originally by Welin, a Swedish engineer, and by him sold to the Vickers Company in England, from whom the United States has purchased the patent rights for this country for the sum of $200,000. In the new breech-block, by cutting the threads with varying radii, it has been possible to reduce the length of the block by 30 or 40 per cent and thus save a great weight and bulk of metal in the body of the gun itself, besides securing a lighter breech-block, and one more easily and speedily manipulated. The mounting of the guns of the 6-inch caliber will be similar to that of the Vickers gun, with certain improvements incorporated by the Bureau.

In closing we would draw attention to an instructive comparison in the tables between the perforation through Harveyized armor and through the new Krupp armor, from which we learn, for instance, that while the new 12-inch gun can perforate 23.42 inches of Harvey armor at the muzzle, it is only capable of perforating at the muzzle 18.75 inches of the Krupp armor, the superiority of the Krupp armor being proportionately marked in the case of all other guns, whether it be at the muzzle or at the 1000-, 2000- or 3000-yards range. We commend this comparison to those Congressmen who are seeking to prevent the country from the purchase of Krupp armor at the reasonable price of $500 per ton demanded by our manufacturers.—*Scientific American.*

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* * *

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ANNUAL REPORT OF THE SECRETARY AND TREASURER OF THE U. S. NAVAL INSTITUTE.

To the Officers and Members of the Institute:

Gentlemen:—I have the honor to submit the following report for the year ending December 31, 1899:

ITEMIZED CASH STATEMENT.

RECEIPTS DURING YEAR 1899.

Items	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Dues	$206 10	$213 12	$970 60	$729 95	$2119 77
Subscriptions	177 58	193 00	204 64	176 45	751 67
Sales	56 44	72 30	106 36	68 60	303 70
Interest on bonds and deposits	164 22	29 86	45 50	9 00	248 58
Advertisements	76 25	253 50	60 00	85 00	474 75
Cash in exchange for check.	10 00	..	..	..	10 00
Certificate Washg. Loan and Trust Co	1063 46	..	..	..	1063 46
Life members fee	..	60 00	90 00	30 00	180 00
Profit and loss	..	1 25	..	..	1 25
Binding	..	6 45	19 00	12 00	37 45
Revenue stamps	..	..	02	..	02
Premium on draft	..	..	..	48	48
Totals	$1754 05	$829 48	$1496 12	$1111 48	$5191 13
Receipts from extra publications					3001 36
Total					$8192 49

Expenditures During Year 1899.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Printing and binding	$ ..	$1320 97	$529 61	$660 54	$2511 12
Salaries	282 40	334 00	300 00	300 00	1216 40
Postage	49 41	78 42	66 69	54 90	249 42
Freight and hauling	4 25	9 25	4 54	4 52	22 56
Expressage	4 12	11 51	6 96	15 81	38 40
Telegrams	1 01	5 24	47	3 68	10 40
Stationery.	32 20	31	72 45	41	105 37
Office furniture	14 25	..	..	..	14 25
Check exchange for cash	10 00	..	..	..	10 00
Cost of articles	95 00	40 00	130 00	50 00	315 00
Certificate surrendered to Washington Loan and Trust Co.	1063 46	..	..	..	1063 46
Office help	..	8 62	..	..	8 62
Bank discount on checks	..	40	2 80	1 70	4 90
Typewriting	..	5 00	..	..	5 00
Clerk's expenses in Washington	..	..	15	..	15
Insurance	..	..	28 00	..	28 00
Map paper	..	..	..	21 12	21 12
Revenue stamps	..	..	..	1 20	1 20
Purchase of back numbers and books	..	..	95	7 25	8 20
Totals	$1556 10	$1813 72	$1142 62	$1121 13	$5633 57

Paid on account of printing and binding extra publications	2402 39
Total	$8035 96

SUMMARY.

Balance of cash unexpended January 1, 1899	$4625 50
Total receipts for 1899	8192 49
Total available cash, 1899	$12817 99
Total expenditures, 1899	8035 96
Cash unexpended January 1, 1900	$4782 03
Cash held to credit of reserve fund	239 14
True balance January 1, 1900	$4542 89
Bills receivable for 1899	788 00
" " " back dues	834 00
" " " binding	13 60
" " " subscriptions.	33 00
" " " sales	22 00
" " " advertisements	375 25
" " " sale of other publications	329 12

Value of back numbers, estimated	825 00
" " Institute property	100 00
	$7862 86
Liabilities for other publications	2514 00
	$5348 86
Estimated value of other publications	3359 00
	$8707 86

RESERVE FUND.

United States 4 per cent consols, registered	$900 00
District of Columbia 3.65 per cent registered bonds	2000 00
" " " coupon bonds	650 00
	$3550 00
Cash in bank uninvested	239 14
	$3789 14

MEMBERSHIP.

Total membership January 1, 1899	858
" " " 1, 1900	885
Increase	27
Number of paper-bound copies of the Proceedings on hand at the end of the year	8508
Number of cloth-bound copies	1426
Total number of copies on hand	9934

1 Vol. X, Part 1, bound in half-morocco.

Very respectfully,

R. H. JACKSON, *Lieutenant U. S. Navy,*
Secretary and Treasurer.

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A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.
2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1900. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.
3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.
4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.
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6. All essays submitted must be either type-written or copied in a clear and legible hand.
7. The successful competitor will be made a Life Member of the Institute. If the essayist second in order of merit receive "Honorable Mention," he will also be made a life member.
8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of the Board of Control.

R. H. JACKSON,
Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *January 1, 1900.*

Vol. XXVI., No. 2. June, 1900. Whole No. 94.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

HIGH EXPLOSIVES IN NAVAL WARFARE.

By P. R. ALGER, Professor of Mathematics, U. S. Navy.

I.

One who gives the matter any consideration must be struck by the fact that the effects of high explosives are greatly exaggerated, not only in the popular mind, but almost universally.

The idea that such public buildings as the Capitol at Washington, and the Houses of Parliament at London, can be destroyed by the explosive carried on the person of an anarchist, can hardly gain the credence of an intelligent man, although such is the apparent belief of many newspaper writers, but the equally unfounded idea that a battleship can be destroyed by a high explosive shell meets with common acceptance. I have heard officers of our own navy argue against the building of large armored vessels on the ground that the coming use of high-explosive shell will render them worthless, and the Navy Department is deluged with letters from all over the country, and from abroad, proposing schemes for firing high explosive shell, the writers invariably claiming that a single shell on their system will destroy an enemy's ship. Moreover, this opinion is apparently held by numerous writers of authority. For example, Mr. H. W. Wilson, in his interesting book, "Ironclads in Action," says, referring to the dynamite cruiser Vesuvius: "The perfecting of the pneumatic gun would be the death-knell of the battleship, and it is hard to see what protection could be devised against its bolts." The same writer speaks disparagingly of the use of above-water torpedoes on cruisers, considering them a greater danger to the vessel carrying them than to her opponent, and that this view is quite generally held in our navy is shown by the outspoken statements of commanding officers and their requests, in some instances, to the Department, for permission to have the torpedoes removed from the vessels under their command.

Under these circumstances I have thought that it might be of interest to present to the readers of the Institute the conclusions which I have formed in regard to the value of high explosives in naval warfare, though I fear that these opinions are too contrary to those commonly held to command ready acceptance.

In the first place, it is well to try to form a clear idea of just what an explosion is, and, for our practical purposes, we may properly say, that an explosion is the sudden conversion of a solid or liquid substance into gases of high temperature. But there are different orders of explosion, depending entirely upon the rapidity of this conversion. If you set fire to a mass of gunpowder in the open air it explodes, but the process of its conversion into gases is so slow that before it is completely consumed the gases have expanded and occupy a much larger volume than did the original powder. If, on the contrary, you detonate a block of guncotton by means of fulminate of mercury, you thereby instantaneously convert the guncotton into gases which, having no time to expand during their formation, occupy only the same volume the original solid did. In each case the process is the same, but the difference in the time element produces a vast difference in effects. The explosion of low order, such as that of gunpowder, producing an effect like a push, where the explosion of a high order, such as the detonation of guncotton, produces an effect like a blow on the immediately surrounding objects. Now what we mean by a high explosive is an explosive which can, by proper means, be detonated, or instantaneously, before it has time to expand, converted into gases, and a very important question to consider is, how do the effects of such high explosives, when detonated, compare with the effects of gunpowder?

First, however, let us see what other differences exist between high explosives and gunpowder, besides the peculiar capacity of the former to be detonated, and, also, what differences there are between the principal high explosives themselves which have led to the unanimous selection of guncotton for naval uses.

In what follows the term density of charge refers to the ratio between the weight of an explosive and the volume of the space in which it is contained. If an explosive occupies a space which an equal weight of water would just fill, it is said to have a density of charge of unity, or since 27.73 cubic inches of water weigh one pound, we say that the density of charge is one when the explosive occupies a space of 27.73 cubic inches per pound. If there be 4 x 27.73 cubic inches, or 110.92 cubic inches, to each pound of explosive, we say the density of charge is ¼, etc.

Now, gunpowder burned in a closed chamber at a density of charge of $\frac{4}{10}$ gives a pressure of 10 tons per square inch, while guncotton burned at the same density, by reason of the much greater volume of gases produced, gives 39 tons per square inch, and at a density of charge of unity, while gunpowder gives 42 tons per square inch, guncotton, if contained in an unyielding chamber, would give over 400 tons per square inch. But it has been proven experimentally that the products of detonation do not differ sensibly from those of simple combustion in a closed vessel with high density of charge. Moreover, experiments have shown that the velocity of propagation of detonation is about 1000 meters per second for nitroglycerine, 3000 to 4000 meters for dynamite, and 5000 to 7000 meters per second for guncotton. Imagine, then, a cubic foot of guncotton, having a density equal to that of water, detonated by a fulminate capsule placed on its top. In $\frac{1}{20000}$ part of a second from the beginning of the resulting conversion of the cubic foot of solid into gas, it will have all been converted into gas, which, before it expands, exerts a pressure of over 400 tons per square inch in all directions. Such an enormous pressure must evidently produce the deformation, rupture, and pulverization of materials placed in contact with the explosive. No containing vessel could possibly be made to resist guncotton detonated in its own volume, unless the weight of the explosive were so small that the surface in contact with it conducted off its heat rapidly enough to prevent full development of its explosive force. Of course, as its volume is diminished, the surface of the chamber would have a greater and greater ratio to the weight of explosive it contained, and consequently would more and more decrease the force of the explosion by the absorption of its heat, but the effect of the detonation of any reasonable quantity of guncotton in a closed chamber of its own volume, must inevitably shatter and pulverize the containing walls. With gunpowder, on the other hand, there is no difficulty in constructing containing vessels which it cannot rupture, as instanced by our armor-piercing shell, which have to be loaded with a more powerful explosive than powder in order to be burst.

The difference, then, between detonated guncotton and exploded gunpowder is not only in the instantaneous conversion into gas of the first and the comparatively slow conversion of the latter, but also in the greater volume of gas given off by the former. One pound of gunpowder produces 7740 cubic inches of gases at atmospheric pressure and 0° C., while one pound of guncotton produces 23,810 cubic inches of gases, or three times as much, under the same conditions, about 14 cubic feet against about 4½.

Comparing guncotton with nitroglycerine, next, we find the latter somewhat the more powerful, giving off a less volume of gases, but at a higher temperature, and also, on account of its higher density, being capable of confinement in smaller space than an equal amount of guncotton.

Guncotton, however, is much preferable for naval use to nitroglycerine, dynamite, or any other of the high explosives, on account of its stability and safety in the wet state, and the fact that it cannot be detonated except by fulminate of mercury. Most high explosives, and especially nitroglycerine compounds, can be detonated by shock or heat; guncotton cannot be. It can be set on fire; though, when wet, this is almost impossible, but it only burns freely unless strongly confined. If confined and set on fire, of course the pressure rises until the surrounding walls yield, and if they are strong, an explosion is the result, but numerous experiments have shown that for the detonation of guncotton nothing but fulminate of mercury will serve. When wet, guncotton of good quality will keep indefinitely, with absolutely no change in characteristics. In this state, or when frozen, it can be detonated by the use of a primer of dry guncotton which is itself detonated by fulminate. No other means of detonating wet or frozen guncotton than by this combination of dry guncotton and fulminate has yet been found. Moreover, when wet, guncotton is almost completely inert.

That it is possible to explode wet guncotton under peculiar circumstances we have abundant evidence, but it is only under special conditions that this can occur, and as these are well set forth and explained in the Report of Her British Majesty's Inspector of Explosives in 1881, I shall quote from them as follows:

"It may at first sight appear remarkable that an explosion of wet tonite should be possible. But apart from the well-known fact that guncotton (of which tonite is only a variety) is frequently employed in the wet state, the initiative explosion being established by a detonator and small primer of dry guncotton, we have the evidence of a not inconsiderable number of accidental explosions of this class of material in a wet state as evidence that such accidents are possible.

"In 1878 no less than eight explosions of wet tonite during pressing occurred at these works; in 1879, there was another similar explosion, and another in 1880, and there have been four (exclusive of the present one) during the present year.

"Then we have had two accidents at the Government Factory at Waltham Abbey—one in 1873, and one in 1877; one at the Royal Laboratory, Woolwich, in 1875; and the ignition of a wet guncotton slab while sawing at the same place in 1877. There were also at one time not unfrequent accidents of this sort at Stowmarket; and from some documents which have been furnished to me through the courtesy of M. Maurouard, Inspector-General of 'Poudres et Salpetres' in France, it appears that three explosions have occurred during the pressing of wet guncotton at the factory at Moulin Blanc, viz.: on the 4th September, 1878; 11th July, 1879; and 8th September, 1879.

"All these accidents may no doubt be referred to the same primary cause, although brought about perhaps in different ways in each instance. On this subject, I will quote the explanation which we offer in our Annual Report for 1878, in special connection with the eight wet tonite accidents of that year—

" 'This cause may be stated to be that some small portion of the guncotton is, during the process of pressing or sawing, exposed to the heating, and, therefore, drying influence of friction or pressure. If the friction or pressure be of such a character, or be so maintained upon any portion of the guncotton, as to dry the particles upon which it is exerted sufficiently to render them inflammable, the continuing friction or pressure will, as the next step, establish the actual inflammation of the particles. In the case of the guncotton which took fire in the process of sawing, it is reasonable to suppose that some dry or nearly dry guncotton sawdust had accumulated under the bed of the saw, or in the immediate neighborhood of the point where the inflammation became first established, and this, in its turn, caught fire and produced the accident. In the cases of accidents in the pressing of wet guncotton, whether in hydraulic or steam presses, or in the charging of a shell, if we once assume an ignition of a particle, the resulting explosion can be easily accounted for. The heat generated by the burning of the ignited particles would gradually dry the contiguous portions, and the inflammation would extend with progressive energy until the pressure of the accumulating gases overpowered the resistance of the press, or shell or piston, and (in the absence of some safety-valve or easier method of escape) determined the violent disruption of the containing case. As to how the undue friction becomes first established, that is a point which would have to be determined for each case separately. It may arise from two metal surfaces with only particles of guncotton between them bearing upon one another, in consequence of some defect in the original construction of the machine or tool, or from failure in their application; or, it may be due to the presence of some grit or other rigid substance upon one of the metal surfaces with only a small portion of guncotton interposed. But however the accident may originate in each particular instance, it is, we believe, beyond a question that the rationale of such accidents is to be found in the explanation which we have given above. And it is important to call particular attention to this class of accident and nature of risk, because there is too common a tendency to assume that so long as substances of this sort are wet, nay, that even if they have been at any time wetted, they remain harmless until they have been formally dried, and thus precautions which would certainly not be neglected with the dry explosive are deemed unnecessary so long as the material is in what is assumed to be a damp condition, while arrangements which may be necessary for preventing any portion of the inflammable substance from resuming its inflammable condition during the operations of manufacture are overlooked or disregarded.'

"It will be observed that this explanation involves no suggestion of a detonative explosion having occurred, it simply assumes inflammation first of one particle and then in very rapid succession of other particles, and when such inflammation becomes established under pressure and the gases are unable to escape, an explosion is not only a natural but a necessary consequence. Where, as in the case of the slab of wet guncotton which ignited during sawing, the gases resulting from this inflammation are free to escape, the result is confined to ignition only and does not proceed to explosion."*

The foregoing quotation is important because of the very common belief, especially among those accustomed to the handling of guncotton, that it will stand anything if wet. It is true that *wet* guncotton can only be exploded by the combined use of dry guncotton and fulminate; it cannot be set on fire even, while wet—*but* it must never be forgotten that it is possible to dry and then explode guncotton by a single action. For example, wet guncotton will stand almost any pressure slowly applied, but apply a very high pressure very suddenly, and the resulting heat may first dry and *then* explode it. It is also important to point out that there is a great difference in guncottons with different percentages of moisture. For instance, guncotton containing 15 per cent of water or less can be detonated by fulminate of mercury alone, but if it contains 18 per cent or over, it requires a dry primer as well as the fulminate. Again, perfectly dry guncotton will be detonated with certainty by 2.83 grains of fulminate in close contact with it, but if only atmospherically dried, it takes 5 grains for certain detonation.

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* It was not long after the writing of this paper that the explosion of several pounds of guncotton saturated with water, while being pressed into a 12-inch shell at Dupont's Smokeless Powder Works, resulted in the lamentable death of that accomplished ordnance officer, Capt. Sidney Stuart of the U. S. Army.

Other interesting facts about guncotton are the following:

A dry primer detonated in close contact with wet guncotton will detonate any quantity of the latter, however large and however wet. Saturation, instead of lessening, seems to increase the effect of detonated guncotton. No increase of violence can be obtained by increasing the quantity of fulminate or of dry guncotton. A mass of wet guncotton will have just as great an effect when exploded by a 3-ounce dry primer and a 3-grain fulminate igniter, as if 10 pounds of dry cotton and 100 grains of fulminate were used to initiate the detonation. Close contact, however, is essential when such small quantities are used; the 3 grains of fulminate must not be separated from the dry cotton by more than the very thinnest film of metal, and the dry cotton must have the same close relation to the wet guncotton. No confinement of either wet or dry guncotton is needed for detonation, nor does confinement add in the least to the violence of their explosion when detonated.

Guncotton then, on account of its good qualities, having been adopted by all nations as the high explosive for naval warfare, we have to consider to what uses it is put and whether it can advantageously be used in other ways.

Undoubtedly, in its present use for torpedoes and for destroying obstacles of all sorts, it is much superior to gunpowder. As a submarine mine it will do the work of twice or three times its weight of gunpowder, and by means of two or three small blocks of it, heavy chains, steel rails, booms or other similar obstructions, can be cut in two, where they would be uninjured by large powder charges. But there is one use for high explosives in naval warfare which is not yet developed, but upon the development and towards the introduction of which into general use thousands of people, mostly cranks, but still many intelligent and sensible people, are laboring. I refer to the use of these explosives as the bursting charge of shells, and it is especially to the consideration of whether or not such shell would be more effective than the projectiles in present use, and, if so, how much more effective, that I shall now ask your attention.

What has already been said has shown the first and fundamental difference between the effects of detonated guncotton and of exploded gunpowder in ordinary iron or steel shell filled with them. In the first case, the shell is much more completely shattered and its small pieces are propelled with greater velocity than in the second case. It is this action which makes the shell or bomb containing high explosive so destructive when detonated in a crowd of people; there are so many more pieces than would be given by a powder-exploded shell that more people are killed or wounded.

But granting the fact that the high explosive produces a much more destructive effect upon materials in close contact with it, we have to consider how its action upon its less immediate surroundings compares with that of powder. The following experiment, made at the N. P. G., illustrates this point. Two similar wooden chambers were built, each 10 feet square and 8 feet high, with 6-inch timber posts at corners, sunk 2½ feet in the ground; other 5-inch posts at the middle of the sides, also sunk 2½ feet in the ground; cross-timbers at top, bottom and middle of these posts and secured to them by 6-inch iron spikes, and sides and top from 2 inches to 3 inches thick securely nailed to the framework. In one of these a 4-inch forged steel shell filled with 2¾ pounds of shell powder was burst, and in the other a similar shell filled with 1.9 pounds of guncotton. In each case the shell was placed on a block of oak 1 foot square and 2 feet 7 inches long, in the center of the floor of the chamber; a square yard of cotton sheeting was hung on the wall 5 feet away, and an old sheepskin sponge head was placed 6 feet above and directly over the shell. The result of the powder explosion was as follows: The oak block had a small dent where the base of the shell stood; the cotton sheeting took fire; part of the wool was blown off the sponge head but not set on fire; the chamber itself was badly wrecked; its rear wall was forced outward bodily and pierced with five holes; the three sides and door were blown out and badly splintered, some pieces being blown 25 feet away; the heavy door was blown 10 feet away and fell on its face, pierced in two places; the sides were badly splintered and broken up, many planks showing marks of small pieces of shell; the front half of the heavy roof was lifted and fell on top of the rear half, one plank being lodged in a tree near by; the largest piece of the shell found weighed 4 pounds; some pieces struck the roof, and had the building stood it was evident that the dispersion of fragments would have been found to cover a large area in all directions.

The result of the detonation of the guncotton shell was as follows: The oak block was split; nothing was set on fire; the chamber was but little damaged; there was one hole in the roof; the back was blown outward bodily, as in the powder explosion, and had 17 small holes in it; one side had a piece 4 x 7 feet blown out of it, pierced by 4 holes, and its remaining area had 14 holes in it; the front was pierced by 19 holes; a small panel in the door was either blown out or carried away by a fragment; the left side was pierced by 12 holes.

Thus we see illustrated the peculiar difference in effect of the two explosives—the guncotton produces much more violent local effects; breaks the shell into more numerous fragments, and projects them with greater velocity; but its racking effect is much less than that of the powder; the energy of the high explosive is much the greater; but it expends itself largely in rending and shattering materials in close contact with itself.

There would not, then, seem to be any special advantage to be gained by the use of a high explosive as the bursting charge of common shell of small caliber. In order to detonate such shell, fulminate igniters are absolutely necessary, and if wet guncotton is used, a dry primer is also necessary. It is evident, on the face of the thing, that of a shell containing a high explosive coupled with a detonator of five or more grains of fulminate of mercury is a much more dangerous article to handle and fire than is an ordinary powder shell, and to justify the use of the former in place of the latter, considerably greater destructive effect must be demonstrated. But this does not exist under ordinary circumstances of naval warfare. The high explosive shell of small caliber, if fitted with an ordinary detonator, will explode harmlessly outside a ship's plating, or, at the best, after partly penetrating it, in which latter case a great part of the fragments would be harmless. If, on the other hand, fitted with a delayed action detonator, which is perfectly feasible, and made strong enough to penetrate moderately thick plating, the capacity of the shell is thereby reduced and the small quantity of high explosive which it contains will be unlikely to cause any greater damage than would result from the same shell filled with powder; if it burst in a group of men, it will probably injure more, but its general effect will be less. It is important to understand in this connection, that if a shell is not strong enough, or has not energy enough to get through plating, the fact that it detonates on impact will not add, but rather will detract, from its effect. For example, there were fired several years ago at the N. P. G. a number of 6-inch guncotton shells, and one of them against a 7-inch armor-plate. The plate, which was of nickel-steel, was set up on edge and supported by timber struts from the rear, being very much less strongly held than it would have been on a ship's side. The shell, weighing 78 pounds and containing 12 pounds of guncotton, including the dry primer, struck about 2 feet from bottom and 3 feet from edge, where the plate was 6 inches thick, with a velocity of 1225 f. s., and detonated on impact, being broken into innumerable small fragments. The plate itself was neither knocked down, cracked, nor injured in any way, except for a few scratches and a slight depression made by the point of the shell. In fact, I was satisfied at the time that an empty cast-iron shell with same striking energy would have done fully as much damage, and probably more.

We may conclude, then, at least as far as shell of small caliber are concerned, that to be of any real value in naval warfare, they must be strong enough to go through the plating they are likely to be fired at, and that, if so, their destructive effect would be but very slightly, if at all, increased by loading them with a high explosive, instead of with ordinary black powder.

When, however, we extend our inquiry to the field of large-caliber shell, and especially such shell as are designed to carry very large quantities of high explosives, we are met by the fact that this field is but ill-explored. Almost nothing is known of the effects of such shell, and it has been hitherto almost wholly from the study of the results of accidental explosions that we have been able to judge them. Now there are two theories, so to speak, upon which the use of high explosives, as the bursting charges of large shell, may be advocated. You may say: although it is desirable, viewing the extent to which ships are covered with armor, to make all large-caliber shell of sufficiently thick walls to at least penetrate the thin armor, 4-inch, 5-inch or 6-inch, of an opponent, still the effect of such shell, loaded with a high explosive, will be vastly greater than if loaded with powder. Or, second, you may say: let us not try to pierce the armor of an opponent, but rather let us throw against him such huge masses of high explosive that he will be destroyed by their detonation; his sides blown in and his crew killed by the concussion. The second of these is, of course, the theory usually held. To combat the first theory we must show that to substitute 20, 30 or 40 pounds of high explosive with a detonator, for about an equal weight of gunpowder, will not cause any marked increase in the destructive effect of the explosion of a large-caliber, thick-walled shell. To combat the second theory, we must show that the effects of the detonation of 200, 300 or even 400 pounds of a high explosive on the outside of a ship, would be by no means so terrific as is usually imagined.

Let us see, first, what past experience can tell us of the effects of the explosion of moderate quantities of high explosives.

On February 26, 1884, an infernal machine, containing 21 pounds of dynamite, about the equivalent of the same weight of dry guncotton, was detonated in the baggage-room of Victoria Station, at London. This station was a wooden structure, with light wooden partitions, and was very much damaged, especially in the vicinity of the place of explosion, but the local effect is well illustrated by the fact that the brick wall of the London, Chatham and Dover Station adjoining was uninjured. This wall, 18 inches thick, was separated 2 feet 4 inches from the light wooden side of the Victoria Station, and the explosive was about 3 feet inside the latter station, so that it was only from 5 to 6 feet from the brick wall. Similar infernal machines had been placed at the same time in the Charing Cross, the Paddington, and the Ludgate Hill stations, but they all failed to explode.

On March 15, 1883, an infernal machine containing, probably, 28 pounds of dynamite, was exploded at the Government Offices in Whitehall, London. The explosive had been placed on the sill of a window, inside the stone balustrade of a room near the center of the basement floor of the building, which is 4 stories high and of about 280 feet front. Practically all the windows over this whole front were broken by the concussion, but the serious damage was but slight. The official report says: "But the structural effects of any importance were, it will be observed, of an essentially local character, having, in fact, been limited to the room and balustrade where the explosion occurred; to some slight cracking of the masonry above and on either side, and to the injury to the floor of the room immediately above.

If the intention was 'to blow up' the Government Offices, the result fell almost ludicrously short of the conception."

In 1884 Commander Folger made a series of experiments at the N. P. G. to determine the effects of high explosives against the sides or decks of ships. The following are extracts from his report on the subject. First, as regards the explosion of dynamite against vertical plating:

"In this experiment two targets were used. The first consisted of nine 1-inch wrought-iron plates secured by nine 1-inch bolts to 20 inches of live-oak backing, which last was well braced in the usual manner.

"This target did not by any means represent in its capacity for resistance the side of a modern armor-clad, the plating being laminated, and the separate sheets greatly weakened by numerous perforations. They had been manufactured as flooring plates of a monitor's turret, the holes serving for purposes of ventilation. The bolting, also, was defective, being insufficient in quality, in weight, and of poor material.

"Two hundred and sixty-five pounds of dynamite were exploded in close proximity and in contact with this target in ten successive charges, varying in weight from 5 pounds to 75 pounds.

"The injury done the target was hardly noticeable after 70 pounds had been exploded at the same point in six successive charges, and was limited to an inappreciable indentation of the plating, the rupture of one bolt at a defective weld, and a slight springing back of the structure.

"With the 50-pound charge the indent deepened to 3 inches with a diameter of 2 feet 6 inches. Five bolts were broken, and the plates bending forward were slightly separated at the edges.

"With the charge of 75 pounds (in contact, as were all charges above 20 pounds), the indent was deepened to 7½ inches, including the spring outward of plate edges, with a diameter of 3 feet. Four bolts retained fair holding power. The structure had sprung back 2 inches, and had recovered itself in the elastic earth. The middle upright of the backing was somewhat shattered. The outer plate was cracked a distance of 2 feet at the indent in the lines of the perforations.

"While the target was considered as not having sustained vital injury, its weak construction, in particular as regards bolting, was apparent, and its condition unsuitable for the prosecution of the experiments with still heavier charges. The plating was therefore removed, the injured backing timber replaced, and the bracing strengthened by a second series of support.

"As plating, eleven ⅞-inch sheets, which having been manufactured for the sides of an armored vessel, possessed a slight crown, were secured to the backing, using fourteen 1.5-inch bolts of wrought iron. The plates were likewise somewhat weakened by old bolt-holes, though less than those of the previous target. The completed structure, however, though still deficient in strength, represented more nearly the conditions sought for.

"A charge of 100 pounds of dynamite, suspended as in all previous cases of contact so that its weight assisted the bearing pressure, and with outside ignition—85 grains of fulminate in two primers—was exploded against the target with the following results:

"Depth of indent, 2½ inches; diameter, 2 feet. The edges of the plates at the ends were sprung forward about 2 inches, stripping the beveled bolt-heads through the outer plate. The backing structure had sprung back about 2 inches, and had recovered itself. None of the plates were cracked.

"In all of the previous experiments the bed logs and earth in front of the target were shattered and torn, a hole in the latter of a depth of perhaps 3 feet being made at the explosion of the charge of 100 pounds. It being apparent that the angle between the ship's side and the water surface offered conditions favorable to the development of more violent action of the gases, a structure representing the water surface—a 1-inch plate upon logs—was built up to the level of the center of the target, and a charge of 75 pounds was pressed firmly into the angle, and exploded, again using two primers containing 85 grains of fulminate.

"The effects of this charge were notably more decided than those of the preceding one of greater weight, the indent being deepened to 3½ inches, and the backing and bracing considerably racked and strained. The injuries, however, could not be considered as vital, and the target was left standing without repairs of any description for further experiments. The water-surface structure was, of course, demolished, the iron plate being blown to fragments and the logs almost pulverized.

"The conclusion to be drawn from the results obtained is, that a modern armor-clad will not receive material injury by the explosion in superficial contact with iron over water plating of very large charges of dynamite."

Second, as regards the explosion of guncotton on horizontal plating:

"In constructing the target for this experiment, an endeavor was made to represent the strength of 2 inches of steel suitably supported.

"Three perforated wrought-iron plates, similar to those already described in the dynamite experiments, were joined firmly together, using eight 1-inch bolts. The three-fold plate thus formed was bolted to heavy timbers distant from each other about 4½ feet. Two 1-inch bolts were placed at each end, passing nearly through the timber. To eliminate, as far as might be, the effects of the perforations, sheets of ¼-inch iron were inserted on each side of the middle plate, while a third was placed upon the target to receive the charge. There was thus a total strength (nearly) of 3¾ inches of iron.

"Twenty-five pounds of wet guncotton were exploded upon this target, using for ignition (placed above) 20 ounces of dry cotton with 85 grains of fulminate.

"A hole, 7 by 8 inches, about one-half the area of the base of the charge, was blown through all plates with the effects of the explosion reaching a depth of about 18 inches in the rather friable earth beneath. The bend of the plates extended to the timbers, without starting the bolts, with a depth of about 7½ inches."

Recently the Ordnance Department of the army made the following experiments at Sandy Hook: A 12-inch steel shell, containing 78 pounds of emmensite, was suspended vertically with its point in contact with a horizontal 3-inch steel plate resting upon timbers about 2 feet apart on the ground. Sand-bags were piled around so as to enclose shell and plates. The detonation of this shell produced practically no effect upon the plate, but the sideways blast was very violent, throwing the sand-bags in all directions and to considerable distances.

A similar shell loaded with smokeless rifle powder, suspended in the same way, and exploded by simple ignition, produced fully as much effect as the emmensite shell, and in neither case were the results, except as regards greater fragmentation of the shell itself, any greater than would have resulted from a black powder charge.

All of these examples lead to the same conclusion—that the effects of the detonation of moderate quantities of high explosives are very great as far as immediate surroundings are concerned, but are comparatively slight otherwise. In the cases of the infernal machines and of Capt. Folger's experiments, the high explosive charges were not confined in strong-walled shell, and, consequently, their energies were not expended in shattering such shell, and they did more damage to surrounding objects than would otherwise have been the case. The army test of 12-inch shell, first loaded with emmensite and detonated, and then loaded with powder and exploded by ignition, gave a more direct comparison than we have elsewhere, and this surely does not indicate any greatly increased destructive effect from the high explosive. The truth is, that people underestimate the violence of gunpowder shell explosions, and exaggerate the others.

What the effects produced by bursting a 13-inch forged steel shell with gunpowder are, may be judged from the following test made at the N. P. G. in May, 1895:

A closed triangular chamber 7½ feet high was made with three armor-plates as the sides, 18 inches, 18 inches and 12 inches thick respectively, and the two former weighing, with their backings, about 43 tons each. The two perpendicular sides of this triangle were 15 and 7½ feet long respectively, and the short side was formed by the 12-inch plate, which was securely backed and supported by heavy braces and struts from behind. The shell, loaded with 53 pounds of ordinary shell powder, was placed on its side on a 1½-inch plate about 4 feet square on the ground in the middle of the triangular space. The top of the enclosed space was covered by three 3-inch plates, each 10½ x 5 feet, placed side by side. On explosion, the shell burst into many pieces, sixty being recovered, amounting in weight to three-quarters of the total. One of the 43-ton sides of the chamber was moved bodily to the left, its outer end 8 feet and its inner end 3 feet; the other 43-ton side was moved bodily one foot to the right; the three covering plates, which weighed 3 tons each, were thrown into the air, one landing 6 feet away on top of the adjoining butt, a second falling back outside, and the third falling back inside the space enclosed by the vertical armor-plates. The 1½-inch plate on which the shell rested was dished all over its surface, the greatest amount being 8 inches, and a piece 16 x 6 inches was sheared off its side. The heavy armor-plates were dented in several places by fragments of the shell, but otherwise uninjured. Considering the foregoing, I think we may fairly reach the same conclusions in regard to a large-caliber shell of ordinary capacity as in the case of the smaller shell, namely, that to be effective they must be made strong enough to get through the ship's side before they break up or are burst, and that if so made the charges of high explosive which they will contain, amounting to about the same weight as if of black powder, while breaking them into more pieces, will yet not have a sufficiently superior destructive effect, if any more so, to justify their use instead of shell loaded with black powder. If the shell breaks up on the plating, the detonation of its charge will be comparatively harmless, and, since a very large part of the area of modern battleships is covered with armor, this renders it desirable to make the walls of the 13-inch, our largest shell, so thick as to reduce its capacity to about 50 pounds of powder. This shell will go through 6-inch armor whole and, consequently, will be effective over almost the entire area of an opposing ship, but to load it with guncotton and a detonator would, in my opinion, not render it sufficiently more destructive than when loaded with black powder to justify incurring the additional risk to our own ships. The premature detonation of such a shell loaded with guncotton would undoubtedly disable the gun and almost certainly put a turret out of action, while the premature explosion of such a shell loaded with powder would have no injurious effects whatever. On the other hand, the only gain from the use of the guncotton bursting charge would be a somewhat greater number of pieces from the burst shell with a correspondingly increased probability of killing and wounding men exposed to its pieces. Whether loaded with powder or with guncotton, the shell would be harmless if it struck armor which it could not penetrate, and in case it did penetrate the plating and burst inside the ship, the structural damage done by the high explosive would not be greater but rather less than that done by the powder.

It should be clearly understood that this is a question of expediency only; undoubtedly we can load our ordinary shell with guncotton and fire them with reasonable safety from our ordinary guns with the moderate velocities, and we don't do it merely because we don't think it desirable, not because we are waiting for some one to invent a way to do it. The trouble is that the disadvantages outweigh the advantages. The only advantage is greater fragmentation of the shell when it bursts, while, on the other side, are the disadvantages of greater cost, greater danger in using, and greater necessity for care to prevent accident or deterioration. The powder shell, after being loaded and fused, is perfectly safe and needs no looking after, but if you use guncotton you must be always on the lookout to see that the main charge is kept wet, and that the detonator is kept perfectly dry; then you must, for safety and ease of examination, keep your dry primers and your fulminate separate, so that each shell must be prepared just before firing; then the detonating fuse, with the delay-action arrangements necessary to prevent harmless explosion before penetration, is not only expensive, but much more liable not to function properly than is the simple percussion fuse of the powder shell. Finally, as regards danger, while we say it is reasonably safe to fire moderate charges of wet guncotton with properly arranged detonators, yet we must not forget that *any* shell may explode prematurely. Now, if the powder shell explodes in the gun, it does nothing more than perhaps scratch the bore, but if the guncotton shell detonates in the gun, it will probably destroy it Suppose, for example, an obstruction in the bore, which checks the shell up a little in its motion, this is exactly as if it struck the enemy's side and, therefore; if the detonator functions properly you at once have a premature detonation.

It seems evident that to justify incurring these disadvantages there must be shown a far greater gain in efficiency than I have been able to find exists, and, therefore, I am forced to conclude that the use of detonative charges of high explosives in ordinary shell is undesirable. For armor-piercing shell, which cannot be burst by powder, it is of course desirable to use an explosive that will break them up after their passage through armor, but the capacity of such shell is so small that any delay-action detonator would leave no room for explosive, and so we must be content not to detonate, but simply ignite their charges by the ordinary fuse.

One more word about the safety of firing ordinary shell loaded with high explosives, and I am done with them. The springs and air-cushions and other devices for lessening the shock of firing on the explosive charge are utterly useless; indeed, they are worse than useless, for in many cases they would really increase the danger of premature explosion; the only precaution to take is not to have too long a column of the explosive; it is its own inertia, setting it back and compressing its rear layers, that is the danger, and the greater the weight borne on the rear layer the more likely it is to explode. Cushioning can do no good for the reason that the maximum pressure does not come onto the explosive until the shell has moved several calibers, before which time any practicable spring would have been compressed to its limit, so that just when the cushioning is most needed it is not there.

All the foregoing must be understood as applying to shell of ordinary capacity. We have yet to consider the advantages and disadvantages of using high explosives in special shell of very large capacity.

In a paper which I had the honor of reading before the War College some time since, on the subject of probable future developments of ordnance, after stating an opinion similar to the foregoing, I said in conclusion: "In other words, the only possibility with the high-explosive shell is to use as great a weight of explosive as can be safely thrown, to provide means for its detonation on impact, and to trust to the effects of such a detonation outside the ship." "How destructive these effects would be we do not know, but for my own part I believe they are greatly overestimated."

In a succeeding paper I shall describe some experiments which have been made on this subject, and endeavor to show that the use of high-explosive shell, even with the largest admissible bursting charges, is not desirable.

II.

In my preceding paper I endeavored to show that the use of a high explosive as the bursting charge of shell of ordinary dimensions and capacity was undesirable, as not affording sufficiently greater destructive power to justify the greater risk incurred in its use. My conclusions were as follows:

(1) The effect of the explosion of a shell of ordinary dimensions and capacity outside a ship, by reason of its being unable to penetrate the plating which it strikes, is practically nil, whether it be loaded with powder or with a high explosive.

(2) Consequently it is very desirable to make shell sufficiently strong, which means thick-walled, to penetrate the plating of an opposing vessel without breaking, so as to burst inside her.

(3) Such thick-walled shell, when loaded with a high explosive, are more dangerous to handle and fire, and are very little, if any, more destructive in their effects than if loaded with gunpowder.

(4) Consequently, if anything is to be really gained by the use of high explosive shell, it must be by means of shell of very large capacity, or what have been aptly called "torpedo shell."

In this paper, then, I shall consider the popular theory that overwhelmingly destructive effects will be produced by the detonation of very large charges of high explosive against, or even near, a ship.

Much less is known of the field of serious damage which would result from the detonation of 300 or more pounds of guncotton than of that which smaller charges would cause. Experiments have shown that the effects of say 50 pounds of guncotton are extremely local, but perhaps the explosion of 500 pounds would be a very different matter, and it was on account of this lack of knowledge founded upon actual experience that the Bureau of Ordnance undertook the experiments with the Gathmann shell, which I shall now refer to.

But first let us examine the results of a great accidental explosion of which we have detailed information, and see how far-reaching its effects were. I refer to the famous Stowmarket explosion, which took place at the guncotton works of that name in England, on August 11, 1871.

On this occasion, 13½ tons of dry guncotton exploded, and as there had been a few years before an explosion of about 51 tons of black powder at Erith, the official report compares the results of the two explosions and points out the comparatively local effect of the guncotton.

The 13½ tons of guncotton which exploded at Stowmarket was stored in three small wooden magazines, side by side, 14 feet apart, and only separated from each other by brick walls. The noise of the explosion was heard 30 miles and the shock was felt 7 miles. Some windows were broken 4 miles away, and some window-frames and sashes up to about one mile away. Slight material damage was done at distances from one-quarter to three-quarters of a mile away, but, as a general rule, not beyond 450 to 500 yards. Wooden cottages of very light construction were seriously injured at a distance of from 300 to 400 yards from the seat of the explosion, and the brick factory buildings, at distances varying from 20 to 50 yards, were practically destroyed. In the fall of the factory buildings a number of people were killed and wounded, the total of casualties being 24 killed and 50 injured. There is, however, no record of death or injury to any person from the effect of concussion merely. It is stated in the official report on the explosion, that a man standing on the railway, 76 yards from the magazines which exploded, was blown over a hedge and stripped of all his clothes, but was uninjured. The crater of this explosion was 35 yards by 22 yards long, 9 to 10 feet deep. The cause of the explosion was almost conclusively proved to be the presence of acid in the guncotton, probably due to careless manufacture, though perhaps to malice. A secondary explosion of several hundredweight of dry guncotton took place while an attempt was being made to remove it from the ruins of a store-house in which it had been kept and which had been overthrown and set on fire by the first or main explosion. This produced a crater 7⅔ x 8 yards by 3 to 4 feet deep. Terrible as the results of this tremendous explosion appear, I cannot doubt that its effects upon such a structure as that of a modern steel ship would have been insignificant except at very close range. The forces which will overthrow light wooden or brick walls are insignificant compared with those which a steel ship will withstand. Of course, people in the open, or at open ports, and near enough to be struck by the rush of heated gases produced by an explosion, will be either burned to death or killed by the dynamic effect of the blow, but one must be very close to be in danger of this. Far-reaching destruction can only result, if at all, from the concussive effect of the air-wave which is propagated from the seat of the explosion. Take, for instance, the detonation of 300 pounds of guncotton, which would occupy a spherical space of about one foot radius. When the gases, rushing outward in all directions, occupy a space of 20 feet radius, they will have expanded 8000 times, and if confined in such a space, would exert a pressure of only one atmosphere. Of course, the dynamic energy of the gases at 20 feet from the center of such an explosion is still great, and they would do more damage than the mere static pressure indicates, but the illustration shows how rapidly they lose their force as they expand. But independent of and prior to any direct effect of the expanding gases, the enormous pressure caused by their almost instantaneous production gives an impulse to the air, something like a sound-wave, which transmits the initial pressure in all directions. It is this wave of intense compressure, followed by expansion, which breaks windows, etc., even miles away from an explosion. Unfortunately, but little is really known in regard to the intensity of the effects of this air-wave. Within the rather limited field of the direct action of the gases of explosion, it is not possible to draw any exact line between their mechanical effects and those of the air-wave, and although we know that all really distant effects are due to the air-wave, almost nothing is known of how serious such effects are as regards human life.

Granting that at 10 feet or even a less distance from the explosion of 300 pounds of guncotton, the direct action of the gases would be withstood by the side of a steel cruiser, what would be the effect upon people behind that side? If the ports were open, the inrush of heated gases might be sufficient at so short a distance to destroy life; but supposing that there were no opening in the side; could the shock injure people behind it? It is almost inconceivable to me that injury should be done to people completely sheltered by rigid plating as long as such plating is not broken through or down, but I have found that it is not an uncommon opinion that the shock, or concussive effect of an explosion, can be transmitted through an unyielding obstacle and injure people behind it. This was one of the objections urged a few years ago to the Holland submarine boat project. It was said that the explosion of its own torpedo, even at such a distance as not to injure its hull, would yet disable its occupants. Experiments made at the torpedo station, however, completely disproved this. A Lay torpedo shell, 28 feet long by 3 feet diameter, built of about ⅛-inch iron plating and containing animals, was suspended 15 feet below the surface, and mines, consisting of 81 pounds of dry guncotton, also submerged 15 feet, were detonated at *various* distances varying from 305 feet to 80 feet. The last explosion, at 80 feet, bent in the plating of the boat at several places, but in no case were the animals injured, and it was apparent that a further increase in the severity of the shock would simply result in breaking through the plating and so killing the animals by drowning.

From our experiences up to this point, then, we could safely conclude that to do serious damage to a ship, or to her crew, by the detonation of a high explosive in the air outside the ship's plating, it would be necessary to use a sufficiently large weight of the explosive to actually blow in the plating, and that such moderate weights of guncotton as had been tried, up to 100 pounds, had shown but trifling effects of this sort. It remained to be determined, then, by actual test, how serious would be the effects of the largest charges of guncotton which would be likely to be used in shell, and when Mr. Louis Gathmann, of Chicago, presented to the Department his very ingenious plan for firing extraordinarily large charges of guncotton from powder guns, it was decided to give his ideas a test and at the same time to find out whether or not such shell would have the destructive effect generally supposed.

Mr. Gathmann's plan was to construct his shell with a very strong head and very thin walls; the rotating band to be at the bourrelet, or junction of head and body of shell; the outside diameter of body to be considerably less than the diameter of bore of gun, so that the powder gases would surround and press upon the shell; and the base of the shell to be closed only by a gas-tight plunger or piston. By this construction, the shell being filled with wet guncotton, the powder pressure would be transmitted by the movable base-plug and the wet guncotton to the inner walls of the shell, exactly balancing the powder pressure on the outside of the shell walls, and, consequently, theoretically, the shell walls could be made as thin as one pleased without risk of their being either burst or collapsed. Thus, instead of having to put 90 per cent of the total weight of the projectile into the steel body in order to have it strong enough to stand being fired from a gun with high velocity, Mr. Gathmann proposed to put only 60 per cent or less, and to have 40 per cent in the form of explosive.

There were just two weak points in the foregoing theory: 1. The powder pressure in a large gun is by no means uniform throughout the chamber; on the contrary, from the moment the charge is ignited the gases are rushing to and fro, producing excesses of pressure now here and now there, and, consequently, a very thin-walled shell might easily be broken up in the gun, notwithstanding the arrangement for producing equal pressures inside and outside its walls. 2. The entire propelling pressure on the base of the shell was transmitted through the wet guncotton, and, consequently, if wet guncotton could be exploded by such a pressure as was used in the gun, the Gathmann shell would be a failure.

The first difficulty was overcome by making the shell of very strong material—nickel-steel forgings—and their successful operation, as far as this point was concerned, was demonstrated by firing two of them filled with water.

As to the second point, as we knew wet guncotton would stand almost any slowly-applied pressure, and as the charge of the shell was to be of saturated guncotton put in copper cases, and with all interstices filled with water so as to completely fill the shell cavity, we felt reasonably sure that the danger of premature explosion would not be great. As the sequel proved, however, this source of danger was underestimated.

The gun, improvised for the test of the Gathmann shell, was a 13-inch tube forging, bored, rifled and chambered like a 12-inch gun, and having a 12-inch breech mechanism fitted in a heavy steel forging screwed over its rear end. It was calculated to stand an internal pressure of about 10 tons per square inch within its elastic limit, and would undoubtedly have stood very much more without bursting.

The shell contained from 307 to 320 pounds of guncotton each, and were fitted with detonating primers consisting of a fulminate igniter, half a pound of dry guncotton, and about three pounds of wet guncotton contained in a steel primer case with walls one-half inch thick and screwed into the nose of the shell. In the first attempts to explode one of these shells the necessity for close contact between the primer and the main charge was well illustrated. In the primer case a strong diaphragm had been fitted separating the one-half pound of dry from the three pounds of slightly wet guncotton, and the one-half-inch steel walls of the primer case separated the entire detonaing arrangement from the main charge of the shell. The result of the first attempt to explode one of the shells by electricity, using 35 grains of fulminate in the center of the one-half pound of dry guncotton was as follows: There was a very mild explosion, scarcely audible at the bomb-proof near by; the head of the shell was ruptured, a number of pieces being found in the vicinity; the forward copper case containing wet guncotton was torn and its contents scattered all about; and the main body of the shell containing the remaining four copper cases of wet guncotton was pushed some ten or twelve feet from its original position. Evidently the one-half pound dry primer had detonated, but had merely set on fire the three pounds of wet guncotton, separated from it by the diaphragm, and the combined force had nearly ruptured the front end of the shell without exploding or setting on fire the main charge of wet guncotton.

A second attempt was then made with a shell having the diaphragm separating the wet and dry parts of the detonating primer removed. The results were practically the same as before, the head of shell ruptured and the main body, with its charge, thrown a few feet to the rear, sliding along the ground.

To prove that these results were entirely due to the separation of detonator and main charge by the walls of the primer case, and not to any lack of strength or sensitiveness in the guncotton, one of the copper cases containing 71 pounds of wet guncotton, and taken out of the shell which had just failed to function, was exploded on a live oak block 14 x 16 x 15 inches long, by means of a one-pound dry primer and a service igniter of 35 grains of fulminate placed on top of it. The result was perfect detonation, and the complete disappearance of the oak block, not a recognizable portion of it being found. The results other than this, however, were almost nil.

The next experiment made was with a shell having the walls of its primer case perforated by ten holes, each about 1½ inches in diameter, so as to allow a more direct action of the primer upon the main charge of wet guncotton. The dry guncotton in the primer was also increased to 10 ounces instead of 8 as before, and the primer case was fitted with a cover of tin sheeting to keep the water from entering from the shell body and drowning the dry primer. The igniter, as before, was 35 grains of fulminate of mercury, exploded by electricity from a bombproof. The shell was placed on its side on the beach, between two screens constructed as follows: Three uprights 8 x 12 inches were let into the ground about 3 feet each and supported from the rear by braces 10 feet long and 6 inches square. To these uprights were secured, each by six 1½-inch bolts, steel plates about 13 feet long by 7 feet wide and ⅝ of an inch thick. These screens were 50 feet apart, facing each other, and the shell was 15 feet from one and 35 feet from the other. On firing there was complete detonation. A hole in the ground 14 x 9 feet and 1½ feet deep was the principal result. One small fragment of the shell had been driven through each of the screens, and other fragments had struck them, making only slight dents. The plates were not bent, displaced or injured in any other way. Only a few fragments of the shell itself were found and these were small, showing how completely it had been destroyed. A very slightly-built wooden latrine standing on the sea-wall, 93 feet from the shell, and with nothing interposing between them, was only injured by the explosion to the extent of having two or three of its boards displaced by being pulled off from the nails holding them to the framework.

The trifling effects of this detonation of a shell containing 320 pounds of guncotton was, I need hardly say, a complete surprise to most of those present. That a light screen, in no way approaching in strength the side of a steel cruiser, and only 15 feet away from the explosion, should be uninjured was rather a damper to the enthusiasm of people who prophesied the destruction of a ship by a single one of such shells. It was said, however, that even granting the experiment to show only extremely local effects from the explosion, yet these effects were tremendous upon objects in contact with the explosive, and as the idea was to explode the shell by impact against an enemy's ship, it by no means followed that such an explosion would be comparatively harmless. It was still claimed that no armor-plate, however strong and well backed, could withstand the explosion of such a shell in actual contact with it. Accordingly it was determined to make one further experiment to test this point.

The plate used was the ballistic test-plate which had represented the Kearsarge's side armor, and was of nickel-steel, face-hardened, backed with 12-inch oak and two ½-inch skin plates, weighing 28 tons in all. It was 7½ feet high by 16 feet long, and of a thickness tapering from 16½ inches at top to 9½ inches at bottom. This plate was placed against an ordinary target structure, but not tied to it in any way, and other armor-plates were placed at right angles to each end of it to confine fragments. The shell, containing 307 pounds of wet guncotton and a primer of 8 ounces dry, 2 pounds nearly dry, and 35 grains fulminate, was suspended by ropes so that it lay horizontally against the plate and along its middle line. It also had a light wood blocking support. The detonation was perfect so far as could be judged by the character of the report and results, but only comparatively trifling damage was done. The surface of the plate was scarred and roughened as if it had been partly fused, for a length of about 5 feet and a width of 8 inches abreast the suspended position of the shell, and there was some very slight flaking from the surface near the old shot holes. A hole was made in the ground along the front of the plate about 2½ feet deep, and partly as a result of this, and partly, perhaps, by rebound from its supports, the plate was swung away from its original position, one end leaving the target structure about 2 feet. Two 1-inch steel plates on the ground below the projectile were broken up and their pieces driven into the ground and dispersed about the vicinity. The side of the shell itself next the plate was flattened out and burned into a ragged sheet 5 feet long by 8 inches wide, practically fitting into the fused portion of the plate, but detached and falling to the ground. The remainder of the shell was dispersed in very small fragments.

The armor-plates at the sides were practically unchanged in position, and the effect upon surrounding objects, such as a lot of oak blocking on the ground 40 or 50 feet away, was very much less than would have been that of the blast of a 12-inch or 13-inch gun fired with its muzzle at the point of explosion of the guncotton shell.

To observe the effect upon animal life, four chickens had been placed in different positions. One on the ground behind the center of the plate and one foot from its backing. This chicken was entirely uninjured, and upon being released showed no effects of the explosion, thus proving conclusively that people behind an armor-plate need have no fear of high-explosive shell.

One on the ground directly in front of the center of the plate and 43 feet from it. This chicken was killed by a flying fragment, which, of course, indicates nothing of importance. Its feathers were not blown off, except where it was struck, and it appeared to have but that one injury.

A third chicken was placed in one corner of the cellulose compartment of a coffer-dam, practically in front of the plate and 50 feet from it. This coffer-dam, consisting of an armor-plate with a thin steel compartment for cellulose behind it, had been fired through and its back, which faced the explosion, had been torn wide open, so that the chicken, in one corner, had much the position which a man would have if he stood well outboard and close to the side of a ship's port. This chicken was entirely uninjured.

The fate of the fourth chicken is rather mysterious. It was placed in another coffer-dam similar to the one just mentioned, but much nearer the explosion, about 25 feet, and having no perforation in it, so that it could only be affected by concussion coming from above down into the compartment. This chicken was found to be dead, but with no external marks of injury, and what killed it is, as I have said, not at all certain. Possibly it was internally injured by the concussion from the air-wave propagated in all directions and reaching it from above, but more probably it was killed by being in contact with the very thin plating of the coffer-dam and being struck by that, which of course must have yielded somewhat.

This experiment would seem to completely dispose of the theory that a high-explosive shell of very large capacity will blow in the side of an armored vessel if exploded against it. But there is one more objection which has been raised to this conclusion. It is said that the motion of the projectile will greatly increase the effect of its explosion on striking. The idea is that the energy of the projectile will act, as it were, as a tamping to the explosive, the gases of which will tend to continue onward and so will act in that direction with greater force than if they came from a stationary explosive. This is undoubtedly true to a certain extent, but the increase in effect can be only trifling. Suppose, for example, that at the instant of explosion the projectile were advancing at the rate of 1500 f. s., then the gases of explosives would expand in the outward direction with 1500 f. s. greater velocity than they would to the rear; but what is 1500 f. s. more or less when we consider the velocity with which the gases rush from the explosive center under the influence of the pressure of hundreds of tons per square inch produced by a detonation. No, this tamping effect of its striking velocity can add nothing material to the force of a high-explosive shell. We can safely conclude that such a shell, even if of the largest practicable capacity, exploding against the armored side of a vessel would be practically harmless. We can also safely conclude that such a shell, exploding in the air, even very near to an unarmored vessel, would do no serious structural damage to her. In other words, the effective sphere of the torpedo shell is far more limited than is usually supposed; it is superior in its effect to an ordinary powder shell only if it explodes inside a ship or under water close to her side. We have then to decide whether the greater effects of the large capacity high-explosive shell within the above limits are sufficient to justify incurring the greater dangers of their use.

It must be remembered that in the very nature of things that which is dangerous to an enemy is dangerous to ourselves. The powder which propels our shell against the enemy may burst our own guns or explode in handling; the fuse which should act on impact with the opposing ship may act prematurely to our own destruction, etc. The best that we can do is to devise and apply safety devices to render our weapons innocuous until the moment when we wish them to act upon an enemy, but there is always the possibility of premature action with injury to ourselves instead of our opponents. The real question, then, as to the use of any weapon is, how do the chances of its damaging an enemy compare with the chances of its damaging us, and how would the results of its successful use compare with those of its accidental premature use? Take, for example, the use of the Whitehead torpedo on cruisers, in regard to which there is much difference of opinion; if the chance of an accidental explosion before firing is very small and the results of such an explosion would not be very serious, and if, at the same time, a successful hit with the torpedo would put an enemy out of action and there is a fair chance of making such a hit, then the use of the torpedo is not only justified but demanded. But if, on the other hand, an accident of very possible occurrence may prematurely explode your torpedo, and if this explosion would put your own ship out of action, then the use of the torpedo would not be advisable. As regards the torpedo, I am strongly of opinion that the first statement of the case is correct; nothing but a direct blow upon the detonator could explode the torpedo, and the chance of this happening is almost infinitesimal. Moreover, even if it happened, and the torpedo were detonated while in its launching tube, I am satisfied that the damage done would be confined to the torpedo-room. The largest torpedo, the long 18-inch Whitehead, only carries 220 pounds of wet guncotton, and its explosion in a torpedo compartment of ordinary size (16 x 64 x 8 feet = 8192 cubic feet on Kearsarge and Kentucky), while it would of course kill every one in that compartment, would not seriously damage the ship nor, in my opinion, do any damage at all outside of the compartment. It would be much better to have the explosion take place above the water-line than below it, for it might tear a good-sized hole in the ship's side around an underwater tube, while if exploded when being used through an open port above water, the damage to the side would be of no importance, and, moreover, in the latter case there would be a free escape of the gases of explosion. On the other hand, the chance of hitting with your torpedo an enemy attempting to ram you would be very good, and the effect of hitting him would probably be to disable him by at least filling several of his compartments with water and perhaps sinking him.

The use of the above-water torpedo on unarmored ships is, then, in my opinion, very desirable, but when it comes to the use of torpedo shell, it seems to me that the best of the argument is on the other side. We have seen that the chance of the torpedo shell doing very great damage to an enemy, even if it hits him, is comparatively small. All battleships nowadays are well covered with armor against which such shell would be harmless, as they would explode outside it; only in case they struck where they could penetrate would they do great damage.

Moreover, the reduced velocity necessary for the safe firing of torpedo shell considerably reduces their chance of hitting at all. Can we afford to not only reduce the chance of hitting the target but also to greatly reduce the area of target against which a hit will count, for the sake of somewhat greater effects from a successful hit? If a successful hit meant destruction to the enemy, we might, but not otherwise, I think. Then, again, the premature explosion of the torpedo shell would do us the maximum harm that such a shell could do. The above-water torpedo, if exploded prematurely, explodes in the air in a large compartment containing nothing of vital importance, while if it hits it explodes against the underwater side of the enemy where it will do its maximum of damage. The high-explosive shell, on the other hand, if exploded prematurely, is just in the position with regard to our own ship that we hope it to reach in an enemy's ship before exploding; if successfully fired and exploded, it is more likely to burst harmlessly outside the enemy than to penetrate and burst within her. As to the actual chance of such a premature explosion of a torpedo shell, I still hold exactly the same opinion as when I said some time ago, in a paper read at the War College on "Probable Developments in Ordnance," that we could safely fire about 175 pounds of wet guncotton with a velocity of about 1600 f. s. from our present 12-inch gun. I did not mean that there would be absolute safety with such a shell, or as much safety as with a powder shell, because any shell may explode prematurely, and the premature explosion of the guncotton shell would be far more serious than that of the ordinary shell. I do mean, though, that the danger of firing torpedo shell is not too great, provided their use is demanded by other considerations. It is the fact that I do not believe their effectiveness is sufficiently greater than that of powder shell that causes me to conclude that we should not use them; it is not that I believe their use, in a proper way, impracticable. One must be satisfied with low pressure in the gun and, consequently, low velocity of the projectile, and one must not sacrifice safety to the desire to throw too large a weight of explosive. It was going too far which caused the failure of the Gathmann shell. If we had been satisfied to fire it with, say, 4 tons pressure in the chamber instead of 8, it would probably not have exploded prematurely. I don't advocate, and never did, such an arrangement as the Gathmann shell. I believe if we use high explosive shell at all they should be like any other shell, only thinner-walled; but, nevertheless, the Gathmann shell was based upon a correct theory and would no doubt function properly in actual practice as long as the pressure on the wet guncotton was kept low enough. The premature explosion of the one shell that was fired was undoubtedly due, in my opinion, to the setting on fire, either by pressure alone, or by the powder gases getting into the shell body, of the wet guncotton charge. There was no detonation, only an explosion of low order. The rear end of the gun was broken into large pieces, and the rifling remained quite perfect everywhere, whereas a detonation would have smashed the lands quite flat in wake of the shell. The pressure gauges all registered 28 tons, and I am satisfied it was nothing but the excessive pressure produced by the combustion of 394 pounds of powder and 300 pounds of guncotton which burst the gun; the gases could not get out of the muzzle fast enough and so the pressure rose till the gun walls gave way. The effects of the explosion can be seen from the photographs, and it is very surprising to see how the guns and carriages mounted on one side of the gun which had burst escaped injury. Whether such an explosion would have burst a service 12-inch gun cannot be absolutely determined, but I am very strongly of the opinion that it would not have. The detonation of such a shell in the bore would have burst any gun, but with free escape for the gases at the muzzle it is not likely that the simple combustion of the guncotton would produce a sufficient pressure to actually burst a modern gun.

Finally, then, the matter stands thus:

(1) The high explosive shell, whether it contains an ounce or 300 pounds of explosive, must penetrate the side of a ship before bursting in order to do serious damage; however large its charge, it will burst harmlessly against armor.

(2) This makes it necessary to arm our battleships with high-power guns of large caliber, firing armor-piercing projectiles, as the only means of getting through the thick armor of opposing battleships and thus reaching their vital parts.

(3) We can fire thin-walled shell loaded with guncotton from these same high-power guns by considerably reducing the

velocity, but there is much more danger to ourselves with such shell than with powder shell; the chance of hitting with them, on account of their reduced velocity, is much less, and they would be effective only against that comparatively small and unimportant part of a modern battleship which is unprotected by armor.

(4) We can use guncotton, or some other high explosive, instead of powder in thick-walled common shell, such as will pass unbroken through the armor, but its use is more dangerous, and its effect but slightly, if at all, superior to that of powder under the same conditions.

Therefore, in the present state of my knowledge, I am forced to conclude that the advantages of using high explosives in shell are outweighed by the disadvantages, and that unless some new light is thrown upon the subject in the future, we should continue to use powder for bursting charges, and not high explosives.

NOTE.—All the foregoing is in reference to the use of high-explosive shell in naval warfare. Their employment with field and siege batteries on shore is advocated upon stronger grounds of reason, since, especially with the former, the objective generally counts upon more or less exposed bodies of men. There is no doubt that much greater fragmentation of the shell can be obtained from the detonation of a high-explosive charge than from the explosion of a gunpowder charge. There is greater danger to the user and there is more uncertainty of obtaining successful explosion with high-explosive than with gunpowder shell charges, but a well-placed shell, properly exploded, will certainly kill and wound more men in the former case than in the latter. Even here, however, the most exaggerated and false ideas appear to me to be prevalent as to the importance of the advantages gained. All that I have read in regard to the effects of the English lyddite shell in the Egyptian campaign and in the present war in South Africa, has tended to confirm my previous conclusions. Such observers as do not allow their imaginations free play to the end of producing sensational copy seem to have been greatly surprised at the lack of effect produced by what they had been led to believe were fearful weapons of destruction. In Egypt, the frightful slaughter of the Dervishes appears to have been wrought by the Maxim automatic guns, not by shell fire. In South Africa, numerous reports show that the Boers rather prefer lyddite shell to the ordinary kind, their principal objection to the former being that their explosion turns people and things in the near neighborhood yellow. And, finally, I have been told by an officer of our army that the dynamite field-guns used in the Philippines are rather a source of laughter than a dreaded weapon, the natives making a practice of standing up at their trenches and bowing politely after each shot, as if to thank us for our consideration in using such harmless projectiles against them.

In the service of coast-defense guns, there is also an advantage to be derived from the use of high-explosive shell which does not exist in naval warfare. I refer to the torpedo-effect of such shell when exploded under water in close proximity to the hull of a hostile ship. In sea-fighting the flat trajectory is vitally necessary on account of uncertainty of range as well as for many other reasons; but from fixed shore batteries, even mortar-fire may prove effective; and with the latter, or even with ordinary guns at ranges too great to allow of effective fire from a ship, the angle of fall is sufficient to cause shell to enter the water and not to be deflected from its surface. If such shell carry large charges of a high explosive and are fitted with an effective delayed-action detonator, their radius of destructive action is considerably increased over what it would be if they were loaded with gunpowder, for if they explode sufficiently near the under-water body of a ship, they will rupture her bottom plating and either sink her, or at least disable her. The gunpowder shell, on the contrary, however large its charge, would, in my opinion, do no damage by its under-water explosion to the hull of a modern ship of any size unless it exploded so nearly in contact that the actual fragments of the shell were driven through the plating. It is principally because they wish to secure this torpedo-action for mortar shell that the Ordnance Department of the U. S. Army has been for years, and is still, experimenting with high explosives. As far as I am informed, their tests have not tended to encourage the prevalent ideas as to the greatly increased destructive effects produced by high-explosive shell. I have been told that a solid steel shot produced a much more destructive effect upon an armor-plate than did a shell of equal caliber filled with explosive gelatine, both being fired at an angle of some 30 degrees with the normal to the plate, thus confirming the conclusion I reached from the firing of a 6-inch guncotton shell against an armor-plate at the N. P. G. some years ago.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE DEFENSES OF MANILA BAY.

By Lieutenant John M. Ellicott, U. S. Navy.

Only a few years before our war with Spain, that country was threatened with another war whose theater would have been chiefly her colonial possessions in the Pacific. War with Germany over the Caroline Islands was so imminent that military plans for the defense of the Philippines were carefully elaborated, and modern high-powered rifled guns were shipped to Manila and emplaced, while ammunition in vast quantities was received and stored. Thus, in the fall of 1897, there stood before the city of Manila four 9½-inch breech-loading rifles, nine 8½-inch muzzle-loading rifled mortars, four 5½-inch converted breech-loading rifles, and fifteen 6.3-inch muzzle-loading bronze rifled guns of old design, all carefully emplaced behind heavy earthworks, fully equipped and superabundantly supplied with ammunition. All batteries were connected by telephone, and plane tables were arranged at the extremities of measured bases, to give accurate ranges. Drills were carried on continually and with enthusiasm.

The old city of Manila lies upon the right bank of the Pasig's mouth, surrounded by a picturesque medieval wall, fifty feet thick and twenty feet high, and by a deep moat. The wall along the bay front is practically straight, with a bastion at each end and one in the center. Five of the 6.3-inch muzzle-loading bronze rifles stood in the north bastion and eight in the south, while in the center were five muzzle-loading rifled mortars. Many other very old muzzle-loading bronze guns lined this wall, but they were recognized, even by the Spaniards, as obsolete. All the artillery on the walls antedated the German scare. The modern formidable guns then emplaced were located in front of the wall and moat, in earthworks well screened by shrubbery and sod. One 9½-inch rifle was placed under the north bastion and one under the south, while the four 5½-inch converted B. L. R.'s were placed near the center bastion, and four 8½-inch mortars on the flank of the south wall. The two remaining 9½-inch rifles were placed some distance to the southward, on the water front, in the suburb of Ermita.

A new battery, to hold six 15-centimeter Ordoñez rifled guns was built on Sangley Point for the protection of the naval arsenal at Cavite. This was a casemated earthwork of entirely modern character. The Cavite arsenal had also three 6.3-inch Armstrong M. L. R.'s mounted in a stone redoubt, and on Fort San Felipe, a medieval fortress adjacent.

The old fort of San Antonio Abad, which had figured so much in the war history of Manila, was too antiquated for modern artillery emplacement.

Such were the defenses of Manila when the new war cloud gathered in the winter of 1897-8. Much more had been planned, and the incentive of renewed danger brought the plans out for revision and execution. One of the large Spanish ocean liners sent to the Philippines, the Isla de Mindanao, was loaded with guns and munitions of war and started from Spain. Believing, perhaps, that these guns would reach them in time for emplacement at Cavite, the military authorities at Manila sent four of the 15-centimeter rifles belonging to Fort Sangley, about the first week in March, to Isla Grande in Subig Bay. In Manila, however, they added two modern 15-centimeter B. L. R. siege guns to the battery of 5½-inch B. L. R.'s under the west wall, and placed two 12-centimeter B. L. R. siege guns in the circular redoubt on the south mole of the Pasig River mouth, where there were already two 6.3-inch M. L. bronze rifles.

At the same time, the emplacement of batteries for the defense of the entrance of the bay was entrusted to the Navy. This entrance, though very wide, is divided into two channels by a large island called Corregidor.

In twenty-four days the following batteries were ready to defend these channels:

Covering Boca Chica: On the north shore of Corregidor Island, three 8-inch M. L. Armstrong rifles; at Punta Gorda, north side, three 18-cm. Palliser M. L. R.'s, and at Punta Lassisi, farther in the bay, two 16-cm. Hontoria B. L. R's.

Covering Boca Grande: On Caballo Island, three 6-inch Armstrong B. L. R.'s; on El Fraile Rock, three 12-centimeter B. L. R.'s, and at Punta Restinga, three 16-cm. Palliser M. L. R.'s.*

They also reinforced Fort Sangley by one 14-centimeter B. L. R., a few hundred yards up the beach, and were preparing to mount a second beside it when the American squadron arrived. The gun here mounted was taken from the cruiser Ulloa, she being so far dismantled for repairs that they moored her head and stern for battle and retained only her starboard battery.

At all of these batteries were built bomb-proofs in the ground, with covered galleries or trenches for approach, while in sheltered spots near at hand were roomy bamboo quarters for the guns' crews. An abundance of ammunition was provided, and the guns were manned chiefly by sailors from such vessels as were *hors de combat* because repairing at Cavite Arsenal.

A line of mines was laid northwestward from San Nicholas shoal, in Manila Bay, and others were laid in Boca Grande, but firing arrangements for the latter seemed not to have been installed when Commodore Dewey's squadron arrived.

At Subig Bay some hulks were sunk to block the southeast channel, and mines were being laid in the northwest channel when our ships arrived, but the four 15-centimeter guns, through inexcusable and inexplicable procrastination, remained prostrate on Isla Grande. Had they been mounted there or at Fort Sangley at the end of April, 1898, the Battle of Manila Bay might have been quite another story.

The merchant steamer Isla de Mindanao arrived in Manila the last week in April, too late to unload all her munitions of war before the arrival of the United States squadron, and her fate is now a matter of history.

Such, then, were the land defenses of Manila Bay which confronted Commodore Dewey when his squadron stole in silence and darkness towards the entrance at midnight, April 30, 1898. The Spaniards had guarded their work well. U. S. Consul Williams, who remained in Manila till one week before that date and who accompanied the American squadron back, could only learn that numerous new batteries were being erected at the entrance to the bay and that the channels were being mined. No knowledge of the relative strength of the defenses of the two channels could guide the American commander's choice. The wider channel, Boca Grande, was the one selected. The squadron thus passed under the muzzles of nine rifled cannon, some of them modern breech-loaders, and through a mined channel. In Boca Chica it would have encountered eight rifles, two of them breech-loading, and no mines, but there were also in this channel a small Spanish gunboat, the Arayat or Leyte, and a picket launch.

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* The Caballo Island guns were taken from the dismantled cruiser Velasco. This battery therefore received the name of that cruiser and was manned from her crew. One of the Fraile guns was taken from the Ulloa and two from the gunboat Leyo. This battery was named Leyo, and manned from that gunboat.

Allowing four large guns as a cruiser's broadside, giving double weight to batteries on shore over those afloat, and counting the mines efficient, it might reasonably be claimed that a contest with the defenses of Boca Grande in daylight would have been about an even fight.

By referring to the diagram showing the zones of gun fire at the mouth of the bay, it will be seen that the United States squadron unwittingly took a course which placed it longest under fire and led it through the zone of heaviest concentration. At the speed the squadron moved, eight knots per hour, and granting most liberal times for the service of the Spanish guns, the latter could have hurled about five tons of projectiles against the American vessels before they were out of range. Nevertheless, the route was well chosen. We all know the actual story: the squadron half way through before detected; then a geyser of flame from the McCulloch's overheated smokestack; a single rocket from Corregidor; a signal flare on El Fraile rock, five impotent shrieking shells from it and Punta Restinga; innocuous mines; and the daring squadron safe within the bay!

Had the Spaniards provided for every contingency, a score of idle gun vessels and armed launches could have patrolled the Manila "bocas" at night, so that even a canoe could scarcely have approached undetected. As it was, the absolute silence and the perfect screening of lights on the American vessels made them undetectable at a few hundred yards distance. The moon in its first quarter was setting behind clouds. A single guiding light, shut in on three sides, was necessarily displayed at the stern of each vessel. The course steered prevented these from being seen from the Restinga and Caballo batteries until the squadron had passed nearly out of their sectors of gun fire. Then, too late, they gave each battery in succession a target: Restinga fired, but Caballo probably thought the enemy already out of range. The flare up from the McCulloch's smokestack was but a brief accident which the Spaniards could not seize to advantage. One feature of the passage was the close approach of the squadron to El Fraile rock. That the Spaniards would have a battery on this isolated and tiny island was not expected, so, as it made an excellent point of departure for a course up the bay, it was approached within five hundred yards, and its battery promptly opened fire. A few shells in return convinced the gunners that their position was perilously exposed and untenable at such short range, and they desisted.

In the face of all evidence, the existence of mines at the entrance to the bay can scarcely be doubted. A chart was captured at Cavite next morning with lines of torpedoes marked on it in Boca Chica and off San Nicholas Shoal, and with marginal memoranda about the spacing and number of mines. In the articles of capitulation signed bv the Governor of Corregidor, it was stated that mines existed in Boca Grande. The testimony of nearly every Spanish officer interviewed by the writer after the fall of Manila was to the same effect. If these mines were contact mines, they had become innocuous from barnacles and seaweed or badly adjusted moorings; if they were electro-controlled, the firing devices had not been installed or were defective.

Having run the gauntlet of nine rifled guns and a line of mines unharmed, our squadron stood up the bay in a direction a little north of Manila, thus safely passing around the mines, if they existed, off San Nicholas Shoal; and in the morning, as it reconnoitered the roads off the city and then stood down toward the discovered Spanish fleet at Cavite, it came under the muzzles of thirty-six rifled guns, twelve of them breech-loaders, and thirteen of larger caliber than any in the American ships. Situated as these guns were, however, they could not fire upon the enemy without drawing a return fire not only upon themselves but upon their city: their homes, their places of business, their wives and children. Nearly nine tons of projectiles could have been hurled at the passing enemy while within range of those Manila guns, but they were paralyzed by their false emplacement. The three batteries of 9½-inch guns, however, being least disadvantageously emplaced, opened, and, through bad marksmanship, kept up an impotent fire throughout the action.

The batteries at Cavite added four hundred and sixty-six pounds of metal to the broadside of the Spanish fleet throughout the first engagement. The duel of the Baltimore with these batteries was a feature of the second engagement. Such a hail of exploding shells plowed into their entrenchments that they resembled volcanic eruptions. Though several times silenced, they as often renewed the fight until their final surrender.

When the work at Cavite was finished, the Olympia steamed alone to Manila, followed soon after by the Baltimore and the Raleigh. These three ships, once more under the muzzles of Manila's thirty-six shotted guns, coolly anchored in the harbor, the bands of the Olympia and Baltimore playing their evening concerts as usual, while Commodore Dewey sent word to the Governor-General that if a single shot was fired at the American ships he would lay the city in ashes.

The isolated batteries at the mouth of the bay were, by orders from Manila, surrendered to the Raleigh and Baltimore on the evening of the 3rd of May. Their breech-plugs were delivered on board the Raleigh. Each battery was visited by landing parties from the American ships, the guns disabled and the ammunition thrown into the sea. At a later period, when it was found that the Philippine insurgents were endeavoring to remove some of the guns, they were all again visited and thrown into the sea.

The guns on Sangley Point were destroyed with gun-cotton. The ones at Manila fell into the hands of the United States Army when Manila was taken, and still remain monuments to the folly of those who emplaced them in such tactically embarrassing positions.

DEFENSES OF MANILA BAY.

About March 10. A council of war at Manila decides to hasten erection of four 15-cm. Ordoñez guns at Subig, block one channel with sunken hulks and mine the other and place the fleet there.

About March 15. The captain of the Leyo submitted a plan for defence of Manila and Cavite, fortifying the mouths of the bay with a line of batteries on points conveniently located and another second line of more moral and material strength, composed of torpedoes protected by two batteries at their extremity, situated between Punta Amos, in the Province of Bataan, and the shoals of San Nicholas. Artillery available:

		Ranges.	
6	Muzzle-loading Armstrong rifles, 180 lbs.	3600	meters.
7	16-cm. conv. M. L. Palliser M. L. 1	5600	"
12	16-cm. conv. M. L. Palliser M. L. 2	5000	"
3	18-cm. conv. M. L. Palliser	4400	"
2	16-cm. B. L. Hontoria, 1879	5000	"
4	12-cm. B. L. Hontoria, 1883	10500	"

Last four on board Ulloa.

Sites visited by a committee on the Bulusan.

March 29. Fraile, Caballo and Restinga chosen; Carabao rejected.

Captain and crew of Velasco land Caballo battery and named it Velasco.

Captain and crew of Leyo land Le Fraile battery and named it Leyo.

120 workmen from Cavite Arsenal and 30 laborers from Corregidor employed on batteries April 1, Leyte, Bulusan and Hercules used.

Fraile battery had one 12-cm. Hont. B. L. R., 1883, from the Ulloa and two 12-cm. Hont. B. L. R., 1879, from the Leyo.

Caballo battery had three Armstrong 16-cm. B. L. R. from the Velasco.

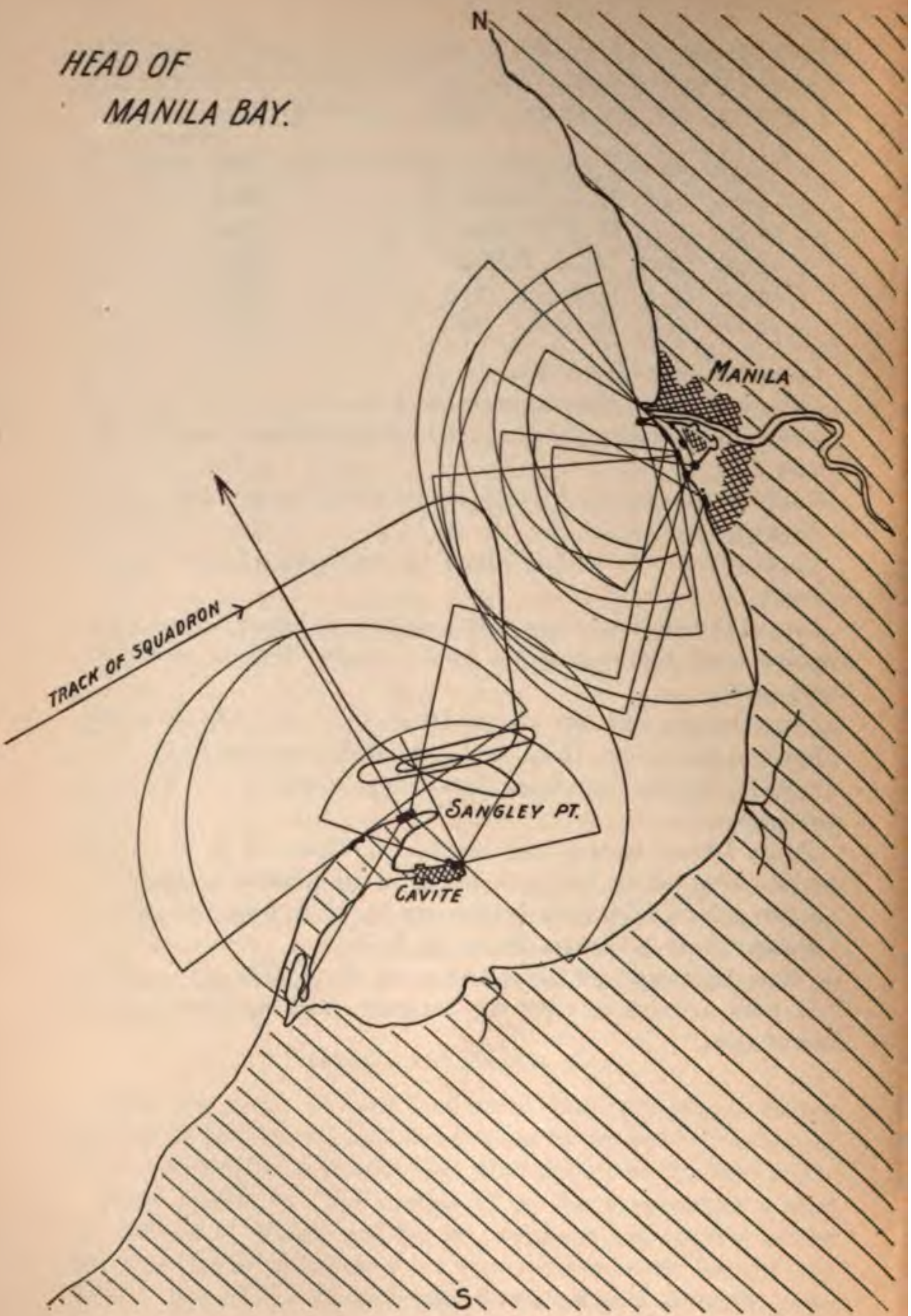
Punta Lassisi battery had two 16-cm. Hont. B. L. R. No. 3 modern 1879, which had been stored in the (Cavite) arsenal.

Corregidor (Talisaz): 3 Armstrong M. L. R. 6-in. 180-pdr.

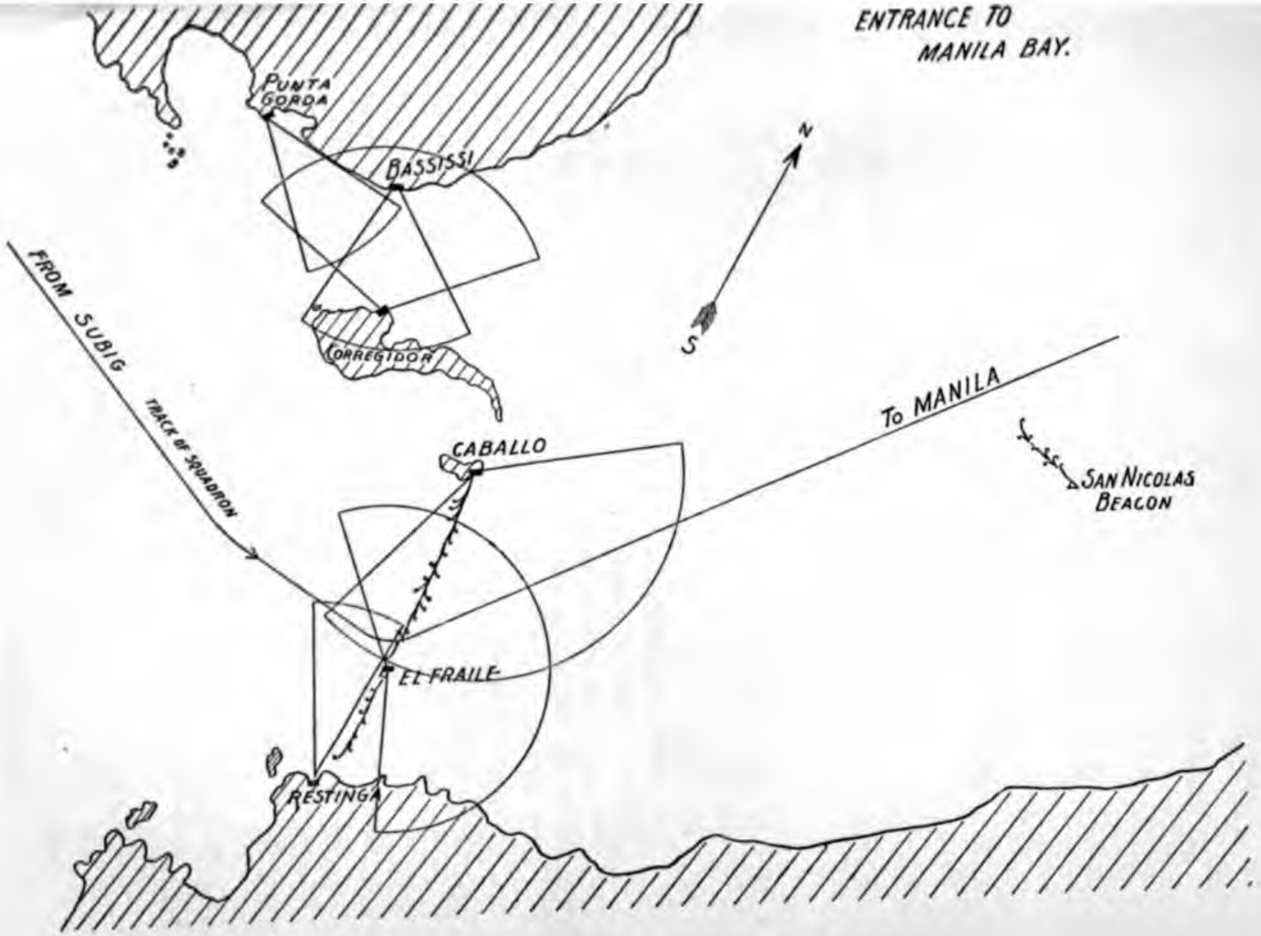
Punta Gorda: 3 Palliser 18-cm. M. L. R.

Punta Restinga: 3 Palliser 16-cm. M. L. R., No. 1.

It took 22 days to erect the batteries, working Sundays and Saints' days.



HEAD OF MANILA BAY.



ENTRANCE TO MANILA BAY.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

AN INTRODUCTION TO THE STUDY OF NAVAL TACTICS.

By René de Cartout, Lt.-Comdr. French Navy.

Translated from the *Revue Maritime* by Prof. Jules Leroux.

Naval Tactics may be defined as the art of disposing fleets for battle; but it is essential to give to all the terms of that definition the extensive meanings they admit of. The art of disposing fleets for battle is not limited to the formations and evolutions that precede or accompany the divers phases of a naval action; it comprises, besides, the whole series of studies and measures tending to the disposition of the elements of combat in every one of the units that constitute the fleets. These preliminary dispositions will permit to be obtained at the decisive moment, the best possible utilization of all the weapons, and will contribute to the final success as much or even more than the purely tactical combinations of the last moment.

Thus the part of the tactician begins long before the actual struggle; in reality it takes place in time of peace, at the moment of the preparations of the designs of the men-of-war, their armament and their assembling into squadrons. It is his duty in the first place, to adopt or reject improvements of all kinds that modern science offers daily for weapons of naval war. However perfect a new weapon, however ingenious seems a mechanism, he must control their employment in regard to their utilization within the special conditions of their performance on board ship; that is, in a heavy sea, and under the enemy's fire. Next, his efforts should be directed towards judiciously gathering together all the means of action at his disposal, to creating types of vessels adapted for the purpose he has in view, to disposing them in homogeneous groups, of which every element completes one another, and lends each other mutual aid.

This important task, the true preparation of all tactics, is not that of the supreme command alone; each captain contributes to it, not only when called upon to superintend the final details of a new vessel, but even when in a ship in commission, his duty is to adjust and utilize the existing arrangements, to make the most of their qualities, to point out and, if necessary, to correct as far as possible their defects. During the first period of his career the officer studies the theory and practical part of all the branches that compose nautical science, branches so various and so complete in themselves that in order to make himself efficient he must confine himself specially to one of them.

But from the moment he takes command he ceases to be a gunner, a torpedoer, or a fusileer, and becomes exclusively a specialist of that complex weapon called a man-of-war. Leaving henceforth with others the care of seeing to the proper performance of the various machinery, he rises to the conception of their simultaneous and judicious action during the combat; that is, of their tactical employment. Each disposition he takes with this object in view, specially during the period of the first armament, exercises a direct influence upon the future results of the struggle during which the collective power of the vessel will be made apparent.

To qualify himself for this work of preparation, a commander should not be contented with the experience acquired in the inferior grades. In most cases the vessel to be disposed for combat has but a remote resemblance to those upon which he has already served. None of the latter will be useful to him as a term of comparison. The "ideal" type, which in his mind conforms with the actual necessities of naval warfare should alone inspire the resolutions he takes, and the appreciations he sets forth. It is therefore necessary for him to possess comprehensive ideas, a theory or, if you prefer it, a doctrine, setting off to his satisfaction a clear conception of what should constitute squadrons and warships.

It is this doctrine that we propose to study in the following pages, without seeking to place it above the inestimable teachings of experience, and with the sole ambition of formulating a few of the general principles upon which, owing to the rapid and radical transformations of the material, rest actually the construction and the constitution of warships.

FIRST PART.

NAVAL WARFARE.

General Notions of War.—The logical basis of every conception of a military order consists, for the officer, in a sound appreciation of the true character and importance of the mission he is intrusted with.

War is not only an unfortunate necessity of our epoch, a remnant of the ancient barbarity we must put up with until nations have acquired the wisdom of coming to an agreement in order to avoid it; such a notion is incomplete, and does not suffice to give to him who is in command the serene and implacable sense of the duty he fulfils. The officer must convince himself that war is something else than an accidental and unfortunate necessity, that it is in reality one of the laws, and perhaps the highest, that presides over the development of society. It is the decisive and inductable phase of the struggle for life legitimately practiced nowadays between nations, after being practiced between individuals, families, clans, and provinces.

In the unceasing and after all profitable conflict of ideas and interests, resort to violence, as a last and supreme argument, can never be done away with as long as there shall exist distinct nationalities, for no one of them has the right to dispossess itself of the inheritance of its intellectual traditions, and acquired wealth, to renounce without being forced to it, its proper existence. The final unification of races and classes towards which tends the unconscious effort of humanity, is compatible only with a higher degree of civilization and ethics from which it is yet very far off.

Universal peace will reign some day, but only through the final conquest and exclusive predominance of the race proving itself the most noble, most intelligent and most powerful. The object of war is to affirm and secure, in view of that far-off selection, the development of national life, through resistance to rival nationalities, or through their assimilation.

Peculiar Characteristics of Modern Wars.—Although war is the fecund instrument that has brought together in the course of ages, and soldered one by one all the elements that constitute the Fatherland, its true mission has been perhaps often misunderstood. It is more apparent nowadays, because progress of the human mind by making wars more rare, has at the same time contributed to make them more murderous. To long armed rivalry of former times have succeeded short and decisive encounters, which diplomacy tries to ward off, knowing full well that they are unavoidable, and in which are manifestly at stake no longer the vain satisfaction of personal ambitions or rancors, but collective interests and often even the very existence of a nation. It can be easily understood that this supreme circumstance demands the concourse of every energy. Thus, social life come to a stand still, commerce suspended, agriculture itself neglected, the whole nation standing fully armed on the frontier, claiming and absorbing all the resources of the country in its deadly work, form the peculiar and striking characteristics of modern wars.

Preparations for war consist, in a general way, in drilling the greatest possible number of valid men, in accumulating the immense supplies they will require in their achievements, and in carefully studying the various plans of attack and defense. There is still another point we must not lose sight of, and this is, that it is not sufficient for a nation in order to establish her supremacy to be the stronger and more intelligent; she must above all be the more noble, in other words, the more moral, and more imbued with her duties. The most terrible arms are powerless in the hands of men deprived of this internal force against which nothing can prevail.

The first and most efficacious preparation for war is the raising of the moral level of a nation. Modern war should not be only the supreme manifestation of intelligence and force, it should besides assume the character of an exalted affirmation of morality.

Of the Rôle and Importance of Maritime Frontiers.—Frontiers being the natural or conventional limits of a country, may in some way be considered as the organs of the exterior life of the country and its relations with other nations. In times of peace they serve to regulate the exchange of different products of the soil, or of industry, and in times of war they constitute the inviolate bulwarks of the Fatherland.

The rôle of maritime frontiers is from this double point of view very different from that of land frontiers. By means of the latter, indeed, one country is in direct contact with its neighbors on the Continent. It is in a certain measure their tributary in a commercial point of view, since its commerce can only be established with them or through their intermediary. It strives to overflow them with the surplus of its productions of all kinds, and in its turn it has to bear the incessant invasion of the merchandise, ideas, and even idioms of its rivals. This unceasing work of assimilation, stimulated by the continuous development of ways of communications, brings on as a consequence, swift and acute state of vital competition between two nations separated by a common frontier. If war breaks out, the attack or defense of this frontier is the initial and dominating fact of the hostilities, of which the seat must necessarily be the territory of one of the two nations. The struggle thus begun may have as a result a modification of the frontier, in consequence of the annexation by the conqueror of the neighboring provinces, or even the crushing and complete assimilation of the vanquished. War between two bordering nations is therefore the most threatening, the most terrible, and the one to be prepared against with the utmost care.

The maritime frontiers through which one country communicates with all other nations plays quite a different part. The sea is the highway open to all, leading to all ports, and it follows that maritime commerce, assuming an importance far superior to that carried on by land, is to the country the real fecund source of greatness and wealth. In a military point of view, the violation of maritime frontiers is in reality an act of a secondary order, presupposing that the ocean fleets constituting the first line of defense have been previously rendered powerless. This violation, besides, constitutes an exclusively maritime operation, limited to the coasts, but can, however, be followed by an invasion of territory through the landing of troops.

War between two nations that do not possess common frontiers begins necessarily by sea, and continues with attacks against the seacoasts. The same may take place in case of two contiguous nations having the same sea outlets, as in the case of France and Italy, for instance. Both countries leaning on the land side against the Alpine mass, have their respective coasts advancing to form the western basin of the Mediterranean. Their commercial relations are more easily carried on by sea than through the mountain passes, hence a conflict of interests which logically would lead them to contend, in the first place, for the supremacy of that common sea.

On the contrary, war between two countries with common land frontiers but separate sea coasts must of necessity be a continental war. It would, however, be unwise in such case to neglect the importance of the maritime frontiers. As already seen, each one of the two countries involved absorbs, for the struggle the totality of its land resources. But these resources are limited, and it may be presumed that the two confronting armed powers, backed respectively by a line of fortified places and entrenched camps, will not succeed at once in terminating the struggle in a decisive battle. It will, therefore, become a matter of great importance to both nations to be able to appeal to the neutral powers, and to receive through their seacoasts the supplies of all kinds, they will need. The navy then will be charged with the double duty of keeping open the access to the coasts and of depriving the adversary by blockade of all communication with the neutrals.

It is proper to call here attention to the particularly favorable situation of France in a geographical point of view. By means of the Mediterranean and Algeria she rules Africa, and through the Canal of Suez, which is her work, she extends her influence to the extreme East. Through her Atlantic coasts she looks upon the New World, and the fleets that spread out from her two maritime frontiers may be compared to two arms always extended towards the unlimited commercial wealth of the globe.

Through her land frontiers, stretching from the south to the north of Europe, she can and ought to exercise a legitimate influence upon the Continent. But let us not forget that maritime commerce alone can furnish her with the material means of exercising that influence. It is from an energetic and wise colonial policy that she must derive the means she is in need of to support the necessary claims of her continental policy.

Object of Maritime War.—The preceding considerations suffice to set off the important rôle of the navy in war, and to determine the object it ought in all circumstances to strive to attain. Whether carried on against a neighboring nation or a country separated by the sea, whether its object be the immediate defense of the coasts of the mother country or the extension and safety of her interests in distant lands, the naval action of a great people purposes always to conquer the supremacy of the seas in determined parts of the globe; that is, to maintain in said parts freedom of communications for herself, and to shut off those of the adversary. It is with the view of satisfying this double object that war fleets must be built and disposed.

Limited Field of Action of Modern Fleets.—Let us first set forth that modern fleets are powerless to realize this object in all parts of the world, to choose indifferently as their fields of operations, the vicinity of the coasts, the European waters, or the distant seas, in imitation of the sailing fleets of the last century. The latter, finding their motive power (wind) everywhere, and being otherwise enabled to procure in every country the supply of food and water necessary for their crews, possessed the unquestionable tactical advantage of an almost unlimited radius of action.

The characteristics of modern fleets are, on the contrary, to join with a great fighting power a very limited radius of action. On one hand the organs of propulsion, powerful engines and large boilers, occupy the greater space of the vessel. On the other hand, the weight of the guns, the armors, and all kinds of machinery constitute the greater portion of the exponent of lading. It is impossible to increase the coal capacity—in other words the vessel's radius of action—without interfering with her speed or fighting power. On the other hand, fuel being properly considered contraband of war, cannot be furnished by neutrals.

Defenses of the Coasts.—The organization of the defense of the coasts is not of paramount importance to a nation whose fleets possess an undisputed superiority upon those of her possible rivals. Great Britain, for instance, can with reason consider her men-of-war as the true bulwarks of her coasts. On the contrary, when a part of the littoral is situated in the immediate vicinity, and subject to the constant menace of a superior maritime power, all kinds of preparation for its defense become a necessity of prime importance. Such is the case of our Channel coast.

The principal object of the defense of the coasts is to oppose a landing, and the squadron should lend all its force in that undertaking. The secondary objects are resisting all the enemy's attempts, such as a temporary occupation of a point of the coast, destruction of semaphores, blockades, bombardments, and the laying of contribution on seaports. In any case, the defense has to face an enemy afloat, and as we have already remarked, is an exclusively naval operation. The troops convoyed by the assailing fleet are inactive; they become offensive only after landing; that is, after an ineffectual attempt to defend the coast; it then becomes a question of defending the invaded territory, which task and responsibility devolve upon the army.

The operations of the navy are always limited to the defense of the coast-line so called. This defense is secured principally by batteries and forts constructed on the shores, in the vicinities of the most accessible points. Those works, having to fight men-of-war, should be armed principally with guns similar to theirs, and capable particularly of piercing their hulls. The methods of firing should even resemble to a degree those employed on board ship against a moving object. The land fortresses are therefore real ships on land, and their sea faces can truly be compared to a broadside of a vessel. The comparison becomes scrupulously true, in speaking of the lower (tier of guns) or armor-piercing batteries, which are often protected by turrets similar to those of a man-of-war. The upper batteries and mortar batteries can also be easily manned by seaman gunners.

Looking theoretically at an action between a fighting ship and a coast battery, one must conclude that the advantage will always remain with the latter. The battery, in fact, can indefinitely increase the thickness of its parapets or steel facings with the use of the disappearing gun-carriage and smokeless powder; it may be made invisible from the sea, and besides possesses a limitless supply of ammunition. The man-of-war, on the contrary, is always in sight. Its protection is limited, and it can only fire a certain number of shots. It follows, therefore, from this statement that the defense of the coast can be secured by forts alone, on the condition that they are completed by sufficient obstructions in the passes, by means of lines of torpedoes and stockades. However, as it would be impossible to build works upon all vulnerable points, their action must be extended and completed by a defense fleet whose units become in turn veritable floating fortresses, endowed with the quality that is lacking on land, motion.

This defense fleet always operating in sight of land from which it can always renew its supplies, needs only a limited radius of action. It can comprise divers types of vessels, monitors, rams, coast-guards, all intended to carry heavy batteries, and capable under certain circumstances of delivering a blow with the ram. It combines its operations with the torpedo-boats, the latter acting in preference by night and surprise, and seeking in daytime protection under the forts or the defense vessels.

Finally, moving columns can be employed to repel shore landings by hostile boats or light-draft vessels.

The elements of this organization so dissimilar in types should combine their action, and obey one sole impulse, which can only be a naval one. We think it useless to expand further upon its working, having only desired to point out the place the defense vessels of the fleet should occupy in it.

Fleet Operations.—The organization of the defense of the coasts can only be the prologue of the naval action of a great power whose territories, subjects, and even flag are scattered or engaged all over the globe. To abandon these interests, to renounce protecting the commercial highways that are the exterior radiating lines of national life, would be equivalent, even in the case of a purely continental war, to a first and irreparable defeat.

It would be vain to object that in such case the fate of the country will be decided on the land frontier, and that naval action, however brilliant, would be without influence upon the issue of the struggle. We think this a very questionable opinion. We have already pointed out the necessity for every belligerent nation to secure not only the safety of, but still more, the access to, their coasts. The possibility of obtaining supplies by sea and preventing the adversary from doing the same may decide the final success.

France particularly has a paramount interest in securing as soon as possible the supremacy of the seas in proximity with her coasts. In regard to Germany, France should be able to close against that power the passages of the Channel and the North sea.

On the other hand, France occupies two shores of the Western Mediterranean Basin, and can no more permit interruption of communications between Alger and Marseille than she can allow the enemy to cut off one of her provinces from the rest of her territory.

Beyond doubt the primary object to pursue in time of war, is to prevent invasion by a hostile army, but there is no reason to think that this cannot be done by sea. In a case where the land frontier is formed by a natural obstacle like the Alpine range, for instance, an adversary having command of the sea may prefer to use the latter as an open and easy passage for his armies. It is, therefore, of the highest importance to the security of the territory to prevent the enemy from obtaining the mastery in the adjacent seas.

That result cannot be obtained by a convenient extension of the coast defenses. Torpedo-boats, as we will show further on, are powerless to realize the object we have in view, and the same would be true of all vessels of high speed, but of a military value inferior to the fighting power of the enemy's battleships. Can we expect the coast-defense monitors to oppose the passage of the adversary? To do that they should have the speed and radius of action they are lacking, they should be joined by cruisers and scouts indispensable to prepare and complete their action—realize, in one word, the deep seas' squadron.

Thus, whichever way we look at it, appears the necessity of maintaining in the North and in the South, two fleets representing the highest expression of the nation's naval power, and whose mission should be to wrest from the squadrons of our possible adversaries the supremacy of the seas adjacent to the country. Those squadrons will play in regard to the coast frontiers the same part the army will play on the land frontier, with this difference, however, that whilst the latter is necessarily massed on the frontier at the opening of hostilities, the naval forces face the enemy in front and apart from the latter.

We have not to examine here how operations will begin between hostile fleets. Both adversaries being alike convinced of the necessity of obtaining the supremacy of the seas, may seek each other from the breaking out of hostilities. It would perhaps be a good idea to force the enemy to accept combat by undertaking at once one of those secondary operations which logically should take place only after the encounter between the two squadrons. Let us simply state that the encounter is bound to take place, and will exercise on the results of a war, even on the Continent, a considerable and perhaps decisive influence.

It is hardly necessary to mention that in case of a war with a naval power, squadrons will play the principal parts. It would be a mistake, for example, to suppose that England's naval power could be seriously shaken by a commercial warfare, *i. e.*, a war undertaken against her merchant marine. The English squadrons, having free possession of our adjacent waters, would blockade our ports and prevent our cruisers from going to sea. If a few of them succeeded in forcing the blockade, it would not be very long before they would be captured by the enemy's cruisers, after a more or less lengthy career, for want of coal. Fleet operations, with a view of keeping open access to our ports, would still be in this case the necessary prologue to privateering.

It will be noticed that up to this we have reserved the name of squadrons to the powerful fleet intended to contend in adjacent seas against European rivals. Naval warfare in distant climes will demand fleets, which to obtain a greater radius of action, must necessarily possess a lesser fighting capacity.

Operations against an Enemy's Coasts.—An attack against coasts can only be an episode of fleet contests; in principle it should follow them, becoming only possible after victory. If we consider in particular the principal object one can possibly have in an attack against an enemy's coast, that is the landing of an army corps, we maintain that this can only take place when protected by a squadron that commands the seas. The necessity of protecting the convoy and material would indeed place such a squadron at a very great disadvantage, if it must besides contend against intact forces of about equal strength. That squadron must also keep off detached cruisers, fight coast-guard vessels, as well as mobile defenses, and if need be destroy works constructed at the points selected for the landing. All these operations, just as in the case of the defense of the coasts, lead to an exclusively general naval action, for the troops brought up can only fall into line after they have landed.

Blockades of navy-yards and commercial ports can only be undertaken by a squadron after the destruction of the adversary. Owing to the restricted field of action of modern fleets it is necessary in such a case to establish in the vicinity of the blockaded place a secondary base of operations, where the assailant can renew his supplies, one vessel after another, and which is connected with the principal base by transports entirely secure against attacks.

The forcing of passes is an operation which a squadron will sometimes find advantageous to undertake if it can afterwards turn around, and attack the enemy's works from the rear. In principle, however, we cannot recommend the attack of a fortified dockyard from the front. A squadron operating alone could not, without risking great losses, attack forts and force an entrance to a first class dockyard, where it could not find a lodging and had no means of occupying. Whatever the injuries inflicted upon the adversary in that action, it would expose itself to the loss of several of its fighting units, and consequently jeopardize the supremacy gained upon the adversary at a great cost. It is only in case of the place being invested landwise by a corps of occupation that it could establish a concerted attack from the sea.

The bombardment of unprotected cities is not to be comprised among the operations that can be taken against an enemy's coast. The squadron, however, will no doubt demand from a commercial city, after sufficient delay, the money, the coal and the provisions it may stand in need of. But to appear suddenly before an open port, to burn and destroy it, would have no importance on the final results, and would be contrary to the higher principles we have advocated at the beginning of this work. It is not usual to fire upon an unarmed mob; firing ceases the moment the adversary strikes his colors, and with more reasons the persons and properties of non-combatants should be respected, except in unavoidable cases. Resistance alone calls for and justifies the use of force.

War on Commerce.—The foregoing conclusions are in part applicable to war on commerce. Operations against the enemy's commerce are certainly among the most potent in striking at its naval power. They complete the actions of the fleet by realizing upon every sea the object of naval warfare, which consists in obstructing everywhere the enemy's communications. By violating this implied interdiction in going to sea under the cover and protection of their national flag, merchantships share in a certain measure in the action of belligerents. They cannot therefore be respected under the same plea as private property of non-combatants.

It must, however, be well understood that the object of war on commerce is capture and not destruction of prizes. It is only through force of certain circumstances when the captured ship becomes a menace or a danger to the captor, that the latter is justified in sinking the prize after, of course, previously taking off the entire crew. This obligation prevents light vessels and especially torpedo-vessels from entering upon commerce-destroying warfare, as having no means of boarding, or putting a prize-crew on board the captured vessel, they could only destroy them and coolly assist in the drowning of its crew. Commerce destroyers should possess heavy tonnage, a great radius of action, and superior speed. Their primary object is to prevent the maritime communications of the adversary.

Resumé.—The rapid *exposé* of the divers requirements of naval warfare just given, sets off the importance—a preponderant one—of properly called fleet operations. These alone by giving the supremacy of the sea. insure the defense of the coasts of the country and make possible attacks on the enemy's coasts, and war on his commerce. Now, as before, naval battles between battleships will decide alone the fate of maritime powers. That truth has not been altered by the radical changes that have taken place in the capabilities of the man-of-war, which being made independent, so to say, of the caprices of the elements, carries within itself the organs of its motion, and all the factors of its power.

SECOND PART.

THE MAN-OF-WAR.

Definition.—The man-of-war, the instrument of naval warfare, we say it again, must be built and fitted to enable it to realize the double object it has in view, namely, maintain free communications by sea for itself, and obstruct those of the enemy. Its mission is to act on the high seas, where it must be able to maintain itself, and sail in perfect safety. We will, therefore, not call by that name craft which, whatever their sizes and armaments, are obliged through stress of weather to seek refuge in port or slow down sooner than merchantmen of the same tonnage. This faculty of keeping the seas, which we will call navigability, is the essential and primary quality we will require from the constructor before thinking of any armaments.

We have seen, on the other hand, that the object of naval warfare is to conquer the supremacy of the sea, by either destroying men-of-war of the enemy or capturing his merchant vessels; it is only exceptionally that its action is directed against the coasts. Though the vessel's guns may be sometimes turned against the latter, the general disposition of its armament must be made in view of an encounter with men-of-war. The man-of-war should thus, it seems to us, be defined in a general way, a deep-sea vessel fitted to combat an enemy afloat.

Nautical Power and Fighting Power.—This definition comprises two parts that correspond to two terms constituting the man-of-war, the vessel itself and the armament, the float and the fortress. The first is endowed with the quality that permits it to move from one place to another, and the second possesses the required military efficiency to combat there. The nautical qualities, navigability, radius of action, speed, turning power, concern not only navigation; they have besides a considerable importance from a tactical point of view. They contribute largely to the efficiency of the fighting part of the vessel, and for this reason it seems to us proper to designate them by the general expression, "Nautical Power," in opposition to "Fighting Power," which comprises the generality of the defensive and offensive dispositions of the ship. It is essential not to mix up these two terms of the power of the man-of-war. We may at once set off the capital difference that distinguishes them from the tactical point of view, by enouncing the following rules, the evidence of which needs no explanation: 1st. A squadron's nautical power is exactly equal to that of the one of its units that has the least. On the contrary, its fighting capacity is the sum total of the fighting capacities of all the vessels composing it. It is perfectly evident that an assembly of vessels possessing different speeds can only move together with the speed of the slowest among them, whilst any ship having an armament and a protection adds to the offensive and defensive power of the whole; 2d. The nautical power of a vessel of a determined tonnage can only be increased at the expense of its fighting power and *vice versa.* Each one corresponds in fact to a weight completing the available fraction of the load exponent.

Before drawing any conclusion from those axioms, it is proper to examine briefly in the logical order of their importance each of the elements that constitute the opposite capabilities of the man-of-war.

Navigability.—The first of all, navigability, comprises several factors, the most important of which is, without contradiction, stability. We must demand that the man-of-way be "uncapsizable," not only from the action of wind or wave, but even—and this is essential—in case of a leak in one of its water-tight compartments. Otherwise compartment divisions instead of proving a security would constitute a danger to the ship. The stability of forms, which is the one we have in view, may be limited to a certain degree, owing to the necessity of obtaining the necessary stability of platform for the efficiency of fire of the guns. It is the constructor's part to establish under his own responsibility the proper compensation between those two terms of the stability and to fix the metacentric height, which joined with the special shape of the vessel gives it in any case the complete security it needs. On our part, we should then renounce in the course of the armament all military installation which would give an increase of weight to the superstructures, and the effect of which would be to reduce the radius of the metacenter.

It is not enough to secure the stability of the vessels; it must besides be made proof against the action of the seas. It is wrong to suppose that all the upper works may be made use of for fighting purpose, beginning at the theoretical plan of the waterline. It is important, in the first place, for the vessel to be enabled to keep up its fighting speed in moderate weather, not, of course, without a certain loss, but without any serious damage resulting or any great inconvenience in the firing of the guns. This essential capability of the man-of-war must be required not only in its solidity but also in its forms forward that are exposed to the action of the waves. This capability, for instance, must never be sacrificed in order to obtain by means of lowered forms the secondary advantage of a depressed fire for the bow-guns.

On the sides, the height of the waves, and the inclination caused by the rolling, render still further part of the upper works useless from a fighting point of view. The line which remains always above water, taking into account these two factors, the freeboard is the true termination of the hull. The part of the hull comprised between the waterline and the freeboard is not below water, but it cannot either be considered as being completely above the water. All the installations projecting out would very often be exposed to the blows of the waves, and would produce seas and sprays troublesome to the firing of the guns. This effect would be still greater in case of that part of hull having a "tumbling home" form. We must then demand before everything, from the constructor, that the plan of the hull up to the freeboard be even and straight.

Finally, the ship should be habitable (have good living quarters), and the crew find in all parts of the vessel, where they must stand, the necessary breathing air. The ventilation of the compartments—above all, those where the temperature is very high—must be abundant, not only under the ordinary conditions of sailing, but even while in action. It is inadmissible that the closing of hatches and doors of watertight compartments should expose the personnel to the danger of being asphyxiated. Let us add that in no case should the simple entrance of fresh air be thought sufficient, but that means must be provided for the evacuation of foul air; finally, to make habitability complete, there should be an upper deck where the men could at least take a few steps in the open air.

Radius of Action.—It is intentionally that we have placed radius of action immediately after navigability. If the latter is the preeminent quality of all deep-sea vessels, we may consider radius of action as the "prime determinante" of the man-of-war. By it the vessel is classified at once in one of the fleets that we judge necessary to the national defense, in the defense fleet, in the squadron, or in division in distant waters.

The radius of action is generally defined by the greater distance the ship can sail with its own means, reducing itself in consequence to economic speed, but in a military point of view, it is preferable to compare between themselves the distances possible at high speed. We will therefore define radius of action as the distance that can be always covered at fighting speed, and we will see further on what is understood by the latter expression.

We have already remarked, and as this study progresses it will be shown still more, that the radius of action can only be increased at the expense of all the other qualities of the ship. It becomes necessary, then, from the very first, to determine the minimum of speed that the vessel must have to perform the duty for which it is intended. It is the part of the tactician alone, that is, of the commander, to determine these first data that the constructor must not reduce under any pretext or circumstances.

The radius of action depends upon the quantity of coal that can be stowed in the ship's bunkers. This quantity should not include the coal for the divers auxiliary apparatus in use for daily life on board ship, or for the working of its interior organs. This fuel, that may be designated as coal for ordinary use, should be regarded as part of the ship's provisions. These supplies of food, fresh water, coal for ordinary purpose, should, like the radius of action, be determined for the constructor according to types corresponding to the fleets enumerated above. They necessitate the reprovisioning of the vessel at the end of a given period, which should be the more extended as the radius of action is itself greater, but these supplies should never be confounded with the propulsion coal which is only consumed in the displacement of the vessel. It may be of interest to remark here that any inopportune displacement of a man-of-war will decrease in part its tactical value by thus reducing the radius of action immediately realizable. We will say a few words, when treating of ordnance further on, about the ammunition supply, which affects only the fighting power of the vessel.

Speed.—Among all the elements of nautical power, speed is unquestionably the one that most directly contributes to the military action of the vessel; it must not, however, be comprised among the factors of the purely military or fighting power, to which it is never more than a useful auxiliary. The vessel possessing superiority of speed can always come up with or get away from its adversary. It is then in that position which can be compared with that of a vessel in former times having the advantage of wind. But, as in former times, this advantage is only really efficacious when at the same time the vessel possesses a superior armament to that of the adversary. When manifestly inferior in strength, it can only use speed to escape.

The speed that can thus contribute to the military action of a man-of-war has little in common with that obtained during trials with forced draft and under peculiar circumstances. The vessel will never again attempt to obtain that speed, for it might be the cause of mishaps that must be prevented by all means. The tactical speed, otherwise called fighting speed, is the one that can be indefinitely kept up with natural draft, without exhausting the personnel or the machinery, the crew being at general quarters. The last condition implies the possibility of passing the coal from the bunkers to the fire-rooms without interfering with the service of the guns or the passage-ways. The speed, or to speak more exactly, the fighting space, corresponds to a definite capacity of the engines, and a given number of revolutions of the screws. That is the one the vessel will commonly adopt in all war circumstances, reserving of course the power of increasing its speed in case of need.

Outside of parts frequented by the enemy, the man-of-war will often find it to its advantage to adopt the economic speed, which will allow it to obtain the maximum radius of action. There exists besides, an evident correlation between radius of action and speed. The two elements complete each other in giving the vessel all its nautical power, which becomes thus truly characterized by what may be called " radiating speed."

Turning Power.—To finish the enumeration of the various factors of the nautical power, there remains to say a few words touching the turning quality of the man-of-war. When the latter had but one screw, the diameter of its turning circle, in fact, described astern a circular zone, where the enemy found himself in a favorable position from the point of view of close attack with the ram or torpedo. The warship has less interest in limiting its gyrating circle since it possesses at least two screws permitting it to maneuver with more facility. It may, however, gain a marked advantage from the possibility of turning without modifying the speed of the engines. The constructor will therefore endeavor to give it this advantage, bearing in mind at the same time that the heeling caused by the turning maneuver must not interfere with the firing of the guns. It should be demanded also that the workings of all the mechanical agencies of gyration, helms, servo-motors, and command-wheels (*roues de commande*), should offer the same guarantees required in weapons of war, and which we will enumerate further on. We might say the same in regard to the motive-engines as well as the vital organs of the vessel which, in its ensemble, is in reality a gigantic weapon that the captain wields by means of the propellers and the helm.

Offensive and defensive Weapons.—The fighting power of the vessel is composed of two distinctive parts but inseparable the one from the other: the offensive power and the defensive. The first comprises the arms intended to act against the adversary, and the second the arrangements of all kinds that allow of their working under the fire of the enemy.

The qualities required in a weapon of war are the following: In the first place, the weapon must be capable of being handled with perfect safety. It is essential that the crew should know that except in case of downright carelessness they have nothing to fear from the forces they put in action. Then the arm must be simple, that is, its mechanism must be worked in an elementary manner. The use of modern arms requires, no doubt, a special knowledge, principally in the mounting and regulating of the apparatus, but the arm must not be at the mercy of an indispensable man, the only one capable of handling it, and who might be wanting at the moment of combat. It is important, in the second place, that these mechanisms should be strong. Whatever their complication, they must be as much as possible proof against injury due to neglect or clumsiness. It is necessary that one should depend absolutely on the proper working of an arm at the very moment of using it. Finally, it must be efficient, in other words, capable of doing the greatest injury to the enemy. The last condition is evidently the most important, but it can only be attained after the other three. However terrible the effects produced by an arm, its adoption should be rejected if there should be any appearance of danger in its handling, if complicated or unreliable. In a word, we want an arm that is at the same time safe, simple, strong, and efficient.

To these qualities, which are general, should be added another, special to arms employed on board a vessel; their working and efficiency should be as free as possible from the motion of the ship. The offensive weapons of a man-of-war are of three kinds: the gun, the ram, and the torpedo. We lay aside small arms, such as rifles, swords, and revolvers, which although very useful, can hardly be considered as part of the armament of a vessel. This armament, intended to fight the enemy afloat, has two objects in view: sink the vessel by attacking the hull below water, or cripple it by acting against its essential organs and personnel, through the destruction of its upper works.

Inverted, the defense proposes to secure on one hand the floatability of the vessel, and on the other the protection of its various machinery and its personnel. These two terms of the fighting power of the ship complete each other. It is not expedient to seek only in a bold and sudden offensive, the means of avoiding the blows of the adversary. At sea, where there is no natural obstacle, no rolling ground, it can be affirmed, specially in view of the recent advance in ordnance, that the best guarantee of an efficient offensive resides in a serious protection.

The Ordnance.—The gun is preeminently the arm of the battleship. Naval battles have always been and are still fought with the gun. The ram and the torpedo appear only as an episode, for the one of the two squadrons having the greater speed can keep a safe distance from their reach. The gun, on the contrary, is the arm of all distances, and suffices to produce the two effects we demand from the offensive weapons; that is, sink the adversary and put him hors de combat.

Its part is to pierce and destroy, and with this double object it uses in principle two kinds of projectiles, armor-piercing shells and high-explosive shells. Both act by impact, for the constant variations of distances between combatants do not permit the use of fuse firing except in special cases, as, for example, when using shrapnel against light craft at a calculated distance. Let us remark that it is sought by loading the armor-piercing projectile with a small bursting charge to produce a certain destructive effect after perforation; conversely, it is sought to obtain the bursting of the shell only after its passage through the hull of the vessel. In both cases we thus come nearer the model projectile, that is of that one capable of producing successively and completely the two results.

The obstacles against which the gun has to contend, if we refer to the enemy afloat, may be divided in three categories. The first comprises the parts of the vessel—for instance, turrets and water-line—that have the maximum protection and carry the heavier armor. Against those obstacles the heavier gun must be used, that is, the one which possesses the greater ballistic power. The ballistic power, which consists in velocity rather than in weight of projectile, is not necessarily in proportion to the caliber and weight of the gun. The power must be sought by using in the manufacture of the piece the most resisting and lighter metal. True, in the present state of metallurgic knowledge, the higher ordnance has necessarily a considerable weight, and the number of the guns on board is limited. They require in their use complex hydraulic or electric apparatus, whose working is slow. Besides, their ammunition supply cannot be considerable.

The firing of the heavy guns is necessarily less frequent and their ammunitions should not be wasted in the combat. It would in the first place, be bad tactics to fire them against obstacles of the second category comprising the parts of the vessel of medium resistance or protected only with a thin armor. Against these, moderate caliber guns will be more efficient. Their rapid fire will permit to throw against them a heavier mass of metal than a big gun could do in the same space of time. Finally, those parts of the vessel that are not protected, the thin plates of the superstructures, and the hulls of light vessels will be pierced or destroyed by the rapid fire of the light guns, which will, besides, act against the exposed crew.

The dividing of the ordnance in three groups, heavy, moderate, and light guns, is thus commanded by the very nature of the obstacles opposed to them, but it must be observed that the rôle of the heavy gun is always predominant. Its blows may be decisive, if the enemy is struck at the water-line, and they are always efficient whatever the part of the ship. There will be some advantage now and then in firing on the upper works with explosible shells of heavy caliber, which will work great destruction. The arrangements in regard to the number and position of the heavy guns constitute consequently the most important factor of the offensive power. Their number being limited by the necessity of displaying in a parallel line the other elements of the ship's power, they must be given the maximum utilization by providing for them an arc of train as considerable as possible. Theoretically speaking, the vessel might mount but one single heavy gun, the number of the fighting units being then increased to a desired proportion. But such an arrangement would constitute a poor use of the appropriation money and, on the other hand, it would not be possible to place this single piece in a position that would command the whole horizon. We are then reduced to the necessity of providing the vessel with at least two heavy guns placed in the axis, one forward, one aft, and having on each side of the median line the most considerable train possible. Those are the two places really fit for heavy guns, and if it is proposed to increase to four the number of these guns, on board large battleships, these two places will be the most desirable for them, two in one turret.

The above arrangement of the heavy guns presents, nevertheless, two objections: the first that an unlucky shot might disable two guns at the same time, but the realized economy of weight permits to give to these guns thus united the maximum protection, and as a consequence to minimize as much as possible this objection. In the second place, the bow pieces and the stern pieces, in crossing their fires, create on each side of the vessel a triangular zone that their fire cannot reach.

The lozenge-shaped disposition of the four heavy guns, that is, one forward, one aft, and one on each side, does not present any of those objections, and theoretically allows firing three pieces at the same time in each of the four principal directions, but this advantage is purely illusory, for the firing in the axis of the guns placed in the center and abeam can only be done by means of a tumbling home or defective form of the upperworks, and can only be carried out at the risk of damaging the fore and after parts with the blasts of the pieces. We reject in principle the use of blast screens, so easily destroyed by the rapid fire of the small guns, and, besides, it increases out of proportion the target presented to the fire of the enemy. In reality the lozenge-shaped arrangement only permits the use of either the forward or after gun, two on the bow or on the quarter, and three only abeam. One of the pieces is always unused in the case of a single object.

The arrangement in couples forward and aft allows, on the contrary, to bear always two guns dead ahead or dead aft, and four on the sides. It, therefore, realizes a superior offensive power with a gain in the difference of weight, since it uses only two turrets instead of four, and it is this arrangement that should logically prevail.

We have claimed for the primary battery the maximum of ballistic power by reducing to a minimum the number of the guns. On the contrary, we shall demand for the secondary battery that it be as numerous and as handy as possible, while preserving the sufficient ballistic power for the work it is intended to perform. As a rule the pieces of the secondary battery may be placed anywhere on board ship where their action is not hindered by the blast of the big gun. In the system of two guns forward and two aft that we have adopted, they will occupy to great advantage the central part of the vessel. The guns nearest the extremities will be able to fire ahead or aft on each side of the turrets of the heavy guns. We think this arrangement preferable to that consisting in placing the fore and after guns of medium caliber on a higher deck. Its difficulty in such case of protecting completely their organs, as well as the necessity of reducing as much as possible the elevation above water of the man-of-war, makes it advisable to place all the guns of the primary and secondary battery on a level. The guns forward should, however, have a greater elevation than those aft, in order to be always serviceable in a heavy sea.

Thus, we save completely the upper tiers for the guns of the light battery, whose dominant quality is their rapidity of fire. There is no advantage in placing this battery very high, for its principal object is to fight the torpedo-boats, and, as such, their pointing in direction is the only one capable of rectification; the firing must be as flat as possible.

The fire of the guns of the light battery placed in the tops is necessarily unreliable, not only on account of the motion of the vessel, but also on account of their elevation above water, which at short distances would make a considerable angle of fall. These guns can only be effective in cases of vessels crossing against the unprotected personnel of the decks or bridges. It is doubtful if that object justifies the use of the fighting masts that support them and are exposed to be destroyed or upset in action by exploding shells, and thus become a danger for the vessel. The masting of armored battleships should only be intended for signals, and constructed so as to present as little target as possible to the shells of the enemy.

The efficiency of firing, apart from the caliber, depends on two factors: accuracy and rapidity. Theoretically, rapidity of fire takes only the second place, but in practice the chances of hitting the enemy increase with the number of projectiles it is possible to fire at him during the time, often very brief, he offers a favorable target. There is, therefore, a great advantage in improving the mechanism of the gun, so as to obtain a rapid fire, not forgetting that ammunition-hoists and passages must have the endurance, safety and simplicity required in the gun itself, besides giving a supply as rapid as the firing of the piece they serve. It is a mistake, we think, to seek the solution of the latter problem in the rapid motion of the hoist, which can only be obtained at the expense of safety. Rapid firing being seldom sudden and unforeseen, and being capable in that particular case of being secured by the reserve supply, the movement of the ammunition coming up from the magazines can be a slow and continuous one, if care is taken to begin it in time. The supply of ammunition from the magazine will then be equal to that spent by the piece.

The rapid firing of the pieces of the secondary battery demands some discrimination. The tactical principle of firing as rapidly as possible the moment the enemy makes his appearance does not apply at sea. The regulating of long distance fire can, in fact, be only approximate, and, moreover, the moderate supply of ammunition on board cannot be renewed during the action. The rapid-fire guns of the secondary battery actually in use would have spent all their ammunition in two or three hours of active firing. It is, therefore, of great importance not to open rapid fire before having obtained the distance by slow firing, or when the flattening of the trajectory renders distance immaterial.

As a principle the heavy guns should only begin fire at the distance where its projectiles can pierce the armor of the hostile vessel. That distance determined beforehand, and which in most cases will be at the same time favorable for the fire of the second battery, will be considered as the fighting distance. The vessel superior in speed and armament will impose that distance on the adversary, in a circular combat, keeping at a safe distance from torpedo attack. In the contrary case, instead of running away, he will generally find it more advantageous to stand head on to the adversary, and if the latter will accept the crossing, he will naturally reserve the fire of his heavy pieces and the most active fire of all his batteries for the moment of crossing to the other bow. He will have determined before hand for the use of each gun on the most suitable projectile; and it is of interest to remark that the disposition in couples of the ordnance permits of the simultaneous use of the armor-piercing shell and the bursting shell at the proper time.

Without insisting further upon those considerations, we may sum up by stating that the primary qualities required from the vessel's batteries are rapidity of fire and flat trajectory. It follows that this ordnance cannot consist of mortars, the weapon of slow fire, and curved trajectory, requiring complete stability of platform and an accurate knowledge of distance. Mortars could be of service in the attack of coast-defense works, and the bombardment of forts, but it may be observed that the vessel's batteries can be used in this special undertaking.

To complete what concerns the battery, it is fitting to speak briefly of the supply of ammunition, which in some sort represents the quantity of military power of which the vessel is capable. These supplies must be determined by the bureau of ordnance, and suited like the radius of action to the military rôle expected from the vessel. In no case can they be modified by the naval constructor, and their adoption must be insisted upon absolutely. The magazines must be situated below the water-line, and in the vicinity of the pieces. Finally, in order to facilitate as much as possible the supply of the gun, the ship's batteries should comprize only three calibers, one for the primary battery, one for the secondary battery and one for the light battery.

The Ram and the Torpedo.—The object of the heavy battery which is to sink the enemy's vessel by piercing the hull at the water-line is continued under water by the ram and the torpedo, which are intended to act by contact against the unprotected parts of the hull. The wounds made by these weapons are generally fatal, but their terrible efficiency is balanced by the difficulties encountered in their use. As a general rule, it is only as the result of a clever maneuver, and by taking advantage of the unforeseen circumstances of the conflict, or against a disabled adversary, that a vessel finds itself in position to deliver a blow with the ram, or to fire a torpedo.

The ram possesses, it must be confessed, in the highest degree the qualities of simplicity and strength that typify a weapon of war. The action by shock, practiced from the earlier periods, and made again possible through the bulk and speed of modern vessels, will remain for a long time to come one of the eventual factors of its fighting power. But it would be wrong to suppose that the ram wielded directly by the captain should be his principal objective during the combat, and the firing of the batteries or torpedoes left to somebody else. In all circumstances the handling of the vessel is made subordinate to the necessity of making the best use possible of all its weapons. It is the captain's part alone to combine their action, to fix the precise moment and the conditions of their use. In the generality of cases, he acts alone by the use of the gun; if he intends to use the ram, he may prepare its action and intensify it by means of his heavy guns and torpedoes.

The captain who should propose as his sole object the attack by shock, would run the risk of witnessing the futility of his efforts. The maneuvering facilities with which, thanks to its twin screws, the modern ship is endowed, would permit it to avoid easily the immediate contact of its adversary as long as it remains manageable. Besides, the shock under great headway may be as dangerous to the assailant as to the assailed. It is a question whether the ram is not limited in its use to attack against a disabled vessel, rendered motionless by the destruction of its propelling power, or forced to follow an immutable course. Even in such case, it must not be forgotten that a vessel threatening another with its bow is in turn exposed to be stopped by a torpedo before attaining its object. The torpedo-launching tubes properly disposed forward, aft and on the sides, play thus a defensive part by creating around a vessel a zone always dangerous to invade. The automobile torpedo may be compared to a ram acting from a distance in all directions. This view of it defines better its tactical use than the assimilation that can be made of this weapon with a submarine projectile. Though it stands midway between the ram and the heavy gun, the slowness of its motion under water, compared with that of a projectile through space, does not allow of its easy training, the sights having principally to reckon with two unknown and uncertain factors, the course and the speed of the adversary. There will be always great advantage in making use of the torpedo at close quarters, with a big chance in favor of its success. The firing of torpedoes by means of submarine tubes makes its success more uncertain. We think it will be often found advisable to fix the tubes and leave with the captain the care of seeking a position favorable for firing the torpedo. However, in case of the ship becoming unmanageable as the result of damage to the engine, it would be an advantage to be able to train the submarine tubes.

Floatability.—Passing now to the study of the defensive arrangements or dispositions, let us state that their principal object is to secure the floatability of the ship threatened at the same time by the heavy ordnance, the ram, and the torpedo. Against the fire of the first, there has not been found up to this time, a better protection than the all around armored water-belt. The minimum height of this belt is determined by the limits between which varies the water-line, according to the rolling or the lightening of the vessel as a result of the consumption of coal and stores. Against the penetrating power of the high-powered projectiles this armor must have a resisting capacity not necessarily commensurate with its thickness and its weight. Progress consists, as in the case of guns of heavy caliber in perfecting process of manufacture in order to produce a metal more and more light and resistant. There will be found great advantage in extending the belt up to the freeboard, with a decrease in thickness.

In the absence of an armor water-belt it is almost illusory to reckon upon a protective deck to secure the vessel's floatability. Useless in this case, if it is situated above the water, it becomes dangerous if it is below, for it obstructs the means of draining at hand. The protective deck must therefore be in turtle-back fashion, with the central part well above water, and the edges reaching below the water-line. It must be remembered, however, that the incline presented on the sides, makes it in that case vulnerable to the high explosive shell, whose bursting is most destructive on the line perpendicular to its trajectory. Even then it should never be used alone, owing to its being more dangerous to stability than the deck entirely situated below the water-line, one single leak being sufficient for the submersion of one whole side of its surface. It is necessary to complete its action with a belt of cofferdams rising on the sides above the water-line, and a cellular division of its upper parts.

However, as there does not practically exist a substance sufficiently light, obturating and incombustible to fill the cofferdams such a method can only reduce in a certain measure the effect of the impact of a projectile at the water-line, by limiting the entrance of water to a few cells situated on the side, and the heeling over that will result may become dangerous to the safety of the vessel if no means are found to remedy it immediately, and above all to drain the flooded compartments.

The defense must abandon the direct protection of the below-water hull against the ram or topedo, and try to minimize as much as possible the effects of the shock of those weapons. It tries to do it by means of the double bottom and the water-tight compartments, as well as by multiplying the means of pumping out the water. The sum of these arrangements, which concern exclusively the constructor, should from a military point of view present all the characteristics of simplicity and safety in their working that we claim for all machineries intended for use during the combat. It is on this condition alone that they will aid effectively in increasing the defensive power of the vessel.

Protection.—It is possible to conceive in theory the possibility of securing in a complete manner the floatability of the vessel. By making itself unsinkable, however, the man-of-war would have only solved one portion of the problem of its defense. The high explosives of modern ordnance acting against its superstructures would soon paralyze its movements and render it perfectly helpless. It is therefore of the highest importance to protect on one hand the organs of the propulsion and gyration, and on the other hand the factors of the offensive power placed on the upper parts of the vessel, that is, the guns of every caliber.

The protection of the boilers and engines is secured by the water-line belt and the protective deck. The latter, of a doubtful efficiency from the floatability point of view, protects, on the contrary, with great efficiency against the direct impact of the projectiles all the interior organs of the vessel. The protecting effect of the armored deck has been further increased by the addition of a screening deck and a second horizontal metal deck, situated above the water-line. The space between the above two decks can be partitioned by a cellular system, and it is thus possible to separate entirely the hull from the upperworks. This separation, however, must not be so complete as to interfere with communications between those parts of the vessel, or hinder the ventilation of the lower compartments.

In what concerns the protection of the batteries, the first requirement is that the system be complete, that is, that it should extend to all the apparatus necessary for the working, loading and training of the pieces. It would be illusory to place part of the mount behind a shield and to leave exposed part of its essential organs. If, for instance, one of the tubes furnishing the water pressure for the hydraulic training apparatus is directly exposed to the enemy's fire, the armor, however thick it may be, protecting the body of the mount, only represents a cumbrous and useless weight.

For the heavy guns, necessarily situated as already explained forward and aft of the vessel, the system of closed and moving turrets, with an armored tube protecting the ammunition hoist, seems best adapted to realize complete protection. The system, however, is not without presenting some objection. It is difficult to manage with sufficient accuracy the rotation of the turrets to secure in a perfect manner the pointing in direction. On the other hand, the impact of projectiles may cause the deforming or jamming of the organs of rotation, and as a consequence render the turret immovable. For those reasons, preference is often given to barbette turrets, fitted with a strong cupola in one with and moving with the mount. In both cases it is important to protect effectively the part extending between the central tube and the base of the turret (*con inférieur de la tourette*), when the latter does not directly rest on the armored deck. The thickness of the plates to be used depends entirely upon the angle at which they may be hit by projectiles. The receding and rounded forms of the cupolas and ceilings allow of their receiving a lesser thickness than the sides. The whole should be able, for the heavy gun, to resist the rupturing projectiles of the heavier caliber pieces, for we must not lose sight of the fact that this heavy ordnance is the principal if not the sole *raison d'être* of the battleship whose offensive power remains entire, or nearly so, as long as it (ordnance) is untouched.

It is only when the pieces of medium caliber are arranged as bow and stern chasers, on board cruisers for instance, that they can be enclosed in turrets or semi-turrets with any advantage. In principle, effective fire should not be sought in the axis of the vessel by broadside pieces, nor even to secure an extended arc of fire, by means of salient sponsons. In most cases of a running fight the chased vessel's object is to fall back on the main squadron or seek shelter in port. Its course forms necessarily with that of the chaser, an angle allowing of the latter using its broadside pieces. In very rare cases where the isolated vessel with plenty of sea-room is in a situation to run dead ahead before the pursuer, the latter is interested in bringing to bear the greatest number of pieces possible. Nevertheless, this consideration becomes only a secondary one, and gives way before the necessity of keeping up speed and direction in all passive weather, which can only be done with the sides even and free from the action of the waves.

We are, therefore, of opinion that the main battery should be disposed in broadsides, behind an armor sufficiently strong to stop explosive shells.

The protection of these guns should, on the other hand, be completed by a system of ceilings, shields, and partitions forming casemates, and intended to minimize as much as possible the effects of the bursting of shells that have penetrated the interior of the vessel.

The light battery should with advantage be arranged in groups on the upper deck behind movable cupolas of sufficient thickness to resist the projectiles of similar guns.

In short, the final adoption of the rapid-fire gun of medium caliber necessitates the complete protection of all the organs of the fighting power of the vessel.

This obligation is principally made imperative for the automobile torpedo, whose delicate mechanisms could not resist the impact of the smallest projectiles. It is impossible to leave exposed to the fire of the enemy the compressed-air torpedoes without running the risk of witnessing the bursting of their air-reservoir. Those weapons can no longer be employed except in the protected parts and below water.

The organs of gyration, helm, tiller-ropes and servo-motors, must be carefully placed out of reach of the enemy's projectiles.

It is not enough to thus protect the machinery; the protection of the personnel who give them life, and could not be replaced during the combat, must be attended to with the greatest care. The captain must not leave the conning-tower (*blockhaus*), from which he directs the movements and the action of the vessel. Neither must the executive and other officers leave their protected stations without necessity. Moving about of the men under the fire of the enemy should be strictly forbidden, or take place only behind the armored sides of the vessel. This necessitates the establishment of a complete system of transmission of orders between the conning-tower and all the parts of the ship. The study of these transmissions completes in a certain way that of the system of ship's protection, and gives it all its value.

In order to realize the ever increasing importance of protection in a modern action one needs only to imagine to himself a duel between two ships, one armed with a powerful but unprotected battery, the other having but one piece of medium caliber, but realizing the most perfect protection of all its organs. Manifestly, the latter would, within a more or less short space, obtain the advantage.

The fighting capacity of a vessel cannot therefore be exclusively measured by that of its offensive weapons. Just as nautical capacity should seemingly be defined by "radius speed" (*vitesse rayonnante*) we shall, putting aside secondary armament, consider only as the characteristics of a ship's fighting power, its batteries protected in every part, counting in even the platform on which they stand.

Actual Antagonism of Nautical Capacity and Fighting Capacity.—We have briefly enumerated the dispositions constituting the fighting and nautical capacities of the man-of-war, and endeavored to formulate in each case the tactical conditions they must answer. It is evident that the type vessel of which we seek to conceive a model should join to the maximum nautical capacity realizable the maximum fighting power possible with the data of modern science. Before examining if the construction of such a vessel is possible let us cast a retrospective look at the sailing vessel constituting, in the beginning of this century, the tactical unit of war fleets.

Nothing could be less exact than to consider the modern fighting ship as a simple improvement upon the ancient man-of-war. No doubt that a comparison between the smooth-bore gun and the pieces of modern batteries is impossible. On the other hand, it is just a waste of needless time to refer to the superiority of the powerful motive engines of the present over the sails and masts of old. Nevertheless, from a tactical point of view, we have taken occasion to remark that finding its motive power in all parts of the globe, the sailing vessel had an almost unlimited radius of action. Its speed, depending exclusively upon its perfection of forms and its exterior sail area, could surpass that of the swiftest of merchant vessels. Its nautical quality was thus carried to a possible maximum without in the least interfering with the development of its fighting power. The latter having, so to speak, a displacement greater than the weight of the pieces it was materially possible for it to carry, could easily attain by increasing the number of its gun-ports, the maximum compatible with the tonnage of the vessel.

To speak the truth, this conception was only completely realized by the frigate. The two and three deckers encumbered themselves with dunnage detrimental to speed, in order to increase their fighting capacity. However, though we see thus appear from that epoch of the unavoidable antagonism between nautical and fighting capacity, it is undeniable that the sailing navy had reached its highest degree of perfection in an almost perfect harmony in the divers factors of its power.

The first appearance upon our vessels of the steam engine marked the point of departure of a new era, of a series of conceptions and dispositions destined in reality, not to perfect but to replace the old navy, by substituting little by little iron and steel to the materials used formerly in the construction of our vessels. We witness only to-day the complete disappearance of masts and the definitive *début* of the entirely metallic vessel. The various elements of its power are incomparably superior, taken separately, to those of the old ship, but if it has a right to expect everything from the progress of metallurgy, the modern ship cannot excel them. It meets at the beginning of its career with a difficulty, at present insurmountable, resulting from the antagonism necessarily existing between its nautical and fighting powers. Let us suppose in fact a hull of a determined form and displacement and let us propose to give it the greatest nautical power possible, that is the greatest radius speed it is possible to attain. It is evident that the vessels having only to consider the internal energy it carries along, the heavy motive apparatus and the fuel necessary for their action, will occupy the sum total of the load exponent. Every weight proper to the offensive and defensive arrangements will have a counterpart in the decrease of the radius of action. If, on the contrary, we wish to obtain the maximum fighting power, the weight of the guns, and their mounts, the turrets, the deck and the armored sides, will soon in turn equal the totality of the available displacement. In the first case, we have built a vessel of great speed but harmless; in the second, we have a powerful one but nearly stationary. Evidently neither of the two answers the conception of a man-of-war, and it is needful to fight the enemy on the water.

Battleships and Cruisers.—How then shall be solved the problem before us? Will it be done by a compromise between the two terms of the power, giving us a vessel with speed and fighting capacity, and having consequently a diminished power in regard to both speed and armament?

We do not think so. The tactician proposes to himself, as we have already explained, to conquer the dominion of the seas in a determined region, that is, to maintain free communications for himself, and prevent those of the adversary. In order to maintain intact those communications he must have the most powerful vessels from a fighting point of view, and in order to paralyze the movements of the adversary he must possess vessels of greater speed.

Now, it would be unreasonable to demand from the constructor vessels that would at the same time possess high speed and be formidable in armament. It would be useless to try to obtain this result by a considerable increase in the displacement and, as a consequence, in that of the available load exponent, for the difficulty in realizing in a complete manner, as necessary, the protection of the organs of the offensive power, increases rapidly with the dimensions of the hull. The solution consisting in laying aside complete protection, in building, like some powers, large vessels incompletely protected, but with great speed, and provided with a powerful battery, is bad and should be rejected. However fast and powerfully armed these vessels may be, they could not contend for the mastery of the sea against vessels, slower it is true, but armed as powerfully, and with their guns protected by heavy armor.

We are thus forced to admit that the modern vessel must be twofold; that the tactical units of our fleets should actually be composed of two factors: the battleship (vessel of the line), possessing fighting power charged with maintaining freedom of communications; the cruiser, with nautical power whose duty would be to intercept those of the adversary. This point being conceded, it should again be affirmed that the separation of these two powers cannot be absolute nor lead to the assembling together of vessels heavily armed, but deprived of speed, and of rapid cruisers without any serious fighting capacity. In reality, we ought not to require in our battleships the greatest quantity, but only the greatest intensity, if we may thus express ourselves, of fighting power. For instance, supposing that the 305 mm. gun is actually the most powerful piece in our batteries, a battleship should carry at least one gun of 305 mm., of which every organ, including the platform on which it stands, should be effectively protected.

The quantity of power can then be increased by increasing the number of vessels. We have seen, on the other hand, that there is an advantage in making four, two forward and two astern, the number of heavy guns, of which it is feasible to completely protect the organs. That primary and necessary condition of the battleship being fulfilled, we will require the constructor to give it the minimum radius of action strictly indispensable for the duty it is to perform, which duty we will have fixed beforehand in absolute manner, and finally, the highest speed, whatever it may be, consistent with its displacement.

On the other hand, if 23 knots, for example, is the highest speed that the best cruisers or ocean-liners of the adversary can make, the cruisers of our squadron should join at least that speed of 23 knots with the radius of action fixed in advance necessary for their special duty, and we will require, moreover, the constructor to provide them with the most powerful protected battery possible.

We see how the terms of the problem fix themselves logically. In either case we cannot coerce the constructor in all the elements of his work. We must leave to his discretion, for battleships, speed, and for cruisers armament. We will simply consider as most perfect the battleships, which without sacrificing any of their fighting powers will have the greatest speed, and the cruisers, which without any loss of speed, will carry the most considerable battery.

For both the greater benefit of the appropriation money will result from the highest ratio obtained, without crowding or overloading, between the total power and the displacement.

We may add that the tactical unit cruiser is only transitory. Its two terms will fatally near one another till they merge together at some distant date, when by the use of a light but tough metal, they will sink their elements into one single type.

Specialization of a Man-of-war.—The fighting ship, be it a battleship or a cruiser, admits, therefore, of all the factors of fighting and nautical powers, but only some of those factors, protected batteries, or radiating speed, attain their maximum intensity, in order to constitute the dominant quality of the vessel, and range it in one of the two great categories we must needs establish.

Some have sought to push further this division of work by specializing the man-of-war, by preserving, for instance, one of its elements of power, and minimizing or even neglecting all the others. Thus is obtained a craft of reduced tonnage, and still very effective from the special point of view it seeks to realize. Among the experiments of that kind which, by the way, have all been more or less condemned in practice, we must cite, first, the torpedo-boat, whose fighting capacity is constituted by one single offensive weapon, and whose nautical power only consists in high speed. The absence, on the one hand, of protection of any kind, and, on the other, the reduction to a minimum radius of action, remove the antagonism of the two powers, and constitute, for a short time, it is true, but with small and economical dimensions, an elegant solution of the naval problem.

It must be confessed, however, that at the present time the torpedo possesses but one of the qualities of a weapon of war—efficiency. It cannot without great risk remain exposed to the fire of the adversary; it requires minute and frequent regenerating; it is subject to breakdowns; in reality, it is neither safe nor simple nor robust, and may fail at the very moment when its use would be required. On the other hand, and in spite of improved sighting devices, the firing of the torpedo is uncertain and should be only practiced at short distances.

Now the torpedo-boat deprived of any protection cannot, in spite of the diminutive target it presents, approach the vessel it attacks without running a most serious risk. This risk is so great with the adoption of rapid-fire and flattened trajectory, that it must renounce day attack and resort only to night action and surprise. Let us add that it is obviously deficient in navigability, an essential quality in all kinds of war crafts. A heavy sea causes a loss of speed and embarrasses considerably the working of its weapons.

Thus, the torpedo-boat is far from being the formidable adversary it is supposed to be for battleships and cruisers. If we even reflect that its tactical speed is not very superior to that of battleships and cruisers, which, by opposing their sterns, may maintain it for a considerable time, under a destructive fire; that besides, theoretically, a surprise is next to impossible; one is forced to the conclusion that if it is not fated soon to disappear, like the ancient fire-ship, the modern torpedo-boat must be modified. It must improve the weapon it carries, and find the protection it lacks, by becoming a submarine, or at least by becoming practically submersible at the moment of attack. It would be premature to consider the consequences following the solution now in sight of such a problem. Quite different is the conception of the ram, of which the only weapon possesses, as we have already remarked, the sum total of the qualities required in a weapon of war; that is, simplicity, safety, force, efficiency and can, besides, realize the absolute protection of its motive organs. However, we have already called attention to the difficulties presented in an attack by shock. The ram being, on the other hand, entirely powerless against an adversary of superior speed, can only acquire the rapidity it lacks without losing any of the complete protection, which is its *raison d'être*, by attaining dimensions proportionate to the vessels it assails. Hence, we are led unavoidably to utilize it with more guarantee, by fitting it with torpedo-tubes and a heavy battery.

The ram thus modified fatally becomes, with an increase of speed, the battleship of our squadrons, or with a lesser speed, the armored coast-defense vessel, whose principal mission is to serve as an auxiliary to the coast batteries, constituting the tactical unit of the coast-defense fleet.

We see that the tentative specialization of the man-of-war, with the object of minimizing dimensions, is fatally doomed to failure; it is impossible to seek a middle term between these two extremes—the submarine and the battleship.

We will, therefore, mention only *en passant*, two other specialized types of fighting ships, the *bateau-canon* and the mortar-dispatch-boat (*aviso-mortier*), though their conception awakened a certain interest.

These vessels, like the torpedo-boats, rely for nautical power on a momentary spurt, and for fighting power on a single offensive weapon deprived of any protection. The "bateau-canon" carries simply one piece of medium caliber, which is powerless against the armor of a battleship or even a cruiser. It has all the defects of the torpedo-boat without, like the latter, the advantage of an efficient arm and the ability of submersion. We will repeat the same about the "aviso-mortier." We can certainly easily imagine a light vessel armed with a mortar of large caliber, throwing a projectile charged with a powerful explosive, a sort of torpedo-ball, of which the impact would produce in the upper works of a battleship a considerable destructive effect. Such a vessel is a veritable torpedo-boat, condemned, like the latter, to act under the cover of night by surprise and at short distances; for mortar-firing with curved trajectory, requiring perfect stability of platform, is out of question on a small vessel.

As to the bombardment of fortified places, it seems that the vessels of the squadron with their staunchness, their protection and radius of action, are far better qualified for this work than the light crafts referred to, which are, besides unable to keep up the blockade in heavy weather, however great their number. Let us then lay aside the dream of the naval dust (*poussière navale*), and maintain, with the majority of officers, the necessity of large vessels at once weatherly and powerful, alone capable of gaining the control of the seas.

Before finishing, we will say a word about a class of vessels which are not properly fighting ships, but which, nevertheless, can render the latter important service. We refer to those crafts which, doing away with fighting power only, preserve as high a speed as is obtainable, combined with a limited radius of action, and among which we will range the estafette, which serves as a link between the two constitutive elements of our fleets, the battleship and the cruiser. Such a vessel, with a sufficient displacement to enable it to maintain speed in moderate weather, is not intended to fight even vessels of similar size, and its exclusive mission is to carry to their destination the orders and information it is the bearer of, by quickly falling back upon the group to which it is attached.

If found expedient to do so without interfering with its nautical power, it can be armed with rapid-fire light pieces to act against torpedo-boats. The estafette, otherwise called despatch-boat or scout, is in some sort the link of the tactical unit cruiser-battleship, and allows the latter to develop all its capacity without a disjunction.

Finally, it should not be forgotten that war on commerce, in spite of the secondary rôle assigned to it, completes the programme laid out for our rapid cruisers, the object of which is to intercept the adversary's sea communications. It would, in such case, be advisable to adjoin, to the latter, vessels capable to act efficiently against merchant vessels, that is, having great nautical capacity, with a certain fighting power. The impressed ocean-liners, fitted with a limited number of pieces of medium caliber, will be useful in this capacity. It is important, however, to observe that the commercial routes must not be abandoned until the enemy has obtained undisputable control of the seas. Although reprovisioning along the seacoasts can be done under neutral flags, in most cases it will be found more advantageous to use for that object the national or home merchant marine.

In a theoretical sense, therefore, it would hardly be a wise policy to divert, at a heavy expense, from their exclusively commercial calling, the steamers of our great transatlantic companies. It would seem preferable to build and have ready special vessels of great tonnage, having great speed and a large radius of action. Some of these destroyers, ordered at the breaking out of hostilities to convenient points, would render great service by paralyzing or at least momentarily embarrassing the commercial shipping of the adversary.

THIRD PART.

MODERN FLEETS.

The First Line Squadron.—Squadrons are reunions of vessels intended to act simultaneously, that is, capable in all circumstances of concerting their movements and actions.

The tactical unit being necessarily composed, as already demonstrated, of two terms, the battleship and cruiser, combining their powers to obtain in its totality the supremacy of the sea, the squadrons will be composed in equal parts of battleships and cruisers.

The squadrons of the first line, which are the highest manifestation of the country's naval power, and are destined to meet the first shock of the enemy, will include the battleships possessing the greatest degree of fighting power joined with the highest possible speed, and the cruisers, whose nautical capacity is superior, or at least equal to that of the adversary's cruisers, and which are, at the same time, provided with an armament and a protection as complete as possible. Swift battleships, with armored cruisers, connected by means of scouts of high speed and seaworthiness, thus constitute the only theoretical elements of such a fleet.

However, by the very reason of the increasing and parallel progress of all branches of navigation, the most recent vessel of each type alone possesses generally all the power resulting from the late progress of metallurgic science, and it could hardly be otherwise. The putting on the stocks simultaneously a great number of vessels of the same design, followed by a forced suspension in the construction, would result in a squadron which, after a few years of active service, could only offer inferior types against the more recent units of the adversary. The constructor, in fact, is powerless to modify his work. Retouchings practiced with great discernment, changes in the batteries or boilers, doubtless may improve considerably the vessel from the fighting point of view; it could only very rarely increase its nautical power, that is, the ratio of its capabilities.

The tactician is confronted in practice with men-of-war of various types and capacities, from among which he must pick out carefully the units of the squadron of the front line, capable always of combining their movements for a common aim.

Of Homogeneity.—In order to concert their action in all circumstances, the vessels of a squadron should be homogeneous, and it is important to know what is understood by this homogeneity, we demand as the quality necessary, but sufficient, of the units intended to constitute the front squadron. We have just seen that it can not be expected that these vessels should be similar. Bearing besides in mind, according to the axiom formulated in the beginning of this study, that the fighting power of a fleet equals the sum of the fighting powers of each one of the units composing it, let us remark that from a strictly military point of view it would seem that we would have an interest in getting together the greater number of vessels possible, whatever their capacity.

Not at all; we know, on the other hand, that the nautical power of the whole exactly equals that of the vessel having the least. The addition of a vessel having an indifferent nautical power reduces, then, to this indifferent value the nautical power of the whole fleet, and the resulting tactical inferiority may balance largely the advantage derived from the fighting capacity of this single vessel. Thus we see that it is necessary to pick out the vessels intended to form the squadron of the front, exclusively among those that possess the requisite homogeneity of nautical power.

From the point of view of navigability, for example, it is evident that all the vessels of the squadron must be able to weather the same gales on the high seas. If one of their number is obliged to seek shelter, the whole squadron, unless it ceases to act in concert, that is, as a squadron, must follow it.

We are forced to the same conclusion in regard to the radius of action, which is, as already seen, the first determinant of the man-of-war, and, consequently, of the squadron. The expected effort of a squadron in time of war demands that it be able to sail, at a fighting speed or economic rate, a given distance. The battleships taking the shorter course, the cruisers should spread in order to form divisions of contact, chase and reconnoissance, and hence sail over a greater distance than the battleships, although a distance also previously fixed upon. The scouts' duties being, on the other hand, to keep in touch with the various fractions of the fleet, they will have a still greater radius of action proportional to the first two. It is not our place to find out here what should be the relation and absolute value of these three radiuses of action of which the sum total constitutes the radius of action of the squadron of the front, and is determined by experiments by the commander-in-chief in time of peace, according to the object proposed in time of war. This determination, we repeat, should logically precede the conception and construction of the vessels intended to compose this squadron, and it is clear that we can afterwards adjoin to them only vessels having at least an equal radius of action. We must rigorously exclude those vessels that might lag behind precisely at the very moment of executing the principal strategic scheme for which the squadron was constituted, as well as the cruisers and scouts which could not fill their mission to the last moment of the projected operation.

It is hardly necessary to add that all the vessels of the squadron must have supplies of victuals, fresh water and coal, for the same length of time. The provisioning of that nature, as well as on the other hand the steaming coal which would be in excess only in some of the vessels, would represent exclusively for the latter a useless weight, stowed and carried at the cost of the real power.

Finally, we must argue in the same way touching speed.

The fighting speed, or tactical speed of the squadron, can only equal that of the slowest of its vessels. We will have, therefore, to consider that the superior speed of the newest types can only be made use of in exceptional cases, and, on the other hand, we must exclude vessels whose slowness would give to the whole a manifest tactical inferiority. This last consideration applies equally, and even with more force, to the cruisers and scouts, which can always find opportunities for superior speed, but which in case of inferior speed would be for the squadron an encumbrance instead of a help. To sum up, the homogeneity of nautical power that we demand for all the units of the squadron consists in the judiciously regulated harmony of the three factors—navigability, radius of action and speed—and we must state that such harmony can only be realized on vessels of a large tonnage. Though scouts may reduce to a minimum their fighting capacity and devote only an insignificant fraction of their load exponent to armament, the necessity of obtaining great speed, a great navigability and a radius of action far superior to that of the *corps de bataille* for which they must reconnoiter, necessarily leads to a considerable displacement, which it seems to us cannot remain inferior to 4000 or 5000 tons.

Light Divisions.—We are thus logically induced to exclude from the squadrons of the front line all light crafts, torpedo-boats, destroyers and despatch-boats, which in time of war can only be for them an encumbrance and even a danger. There will no doubt occur certain circumstances when a squadron will find it advantageous to make use of torpedo-boats, and in that case the commander-in-chief will have in readiness light divisions, independent, stationed at determined points that will, in his direction, lend their special cooperation to the general plan; but these purely strategic combinations have nothing to do with the tactical conception of the squadron we seek to realize, and which could only include, under the name of light division, the assembling of scouts of large tonnage above referred to.

Torpedo-boat destroyers accompanying a squadron can only be of certain use in exceptional cases. Their small radius of action renders them unfit for scouting duties, and, on the other hand, they are more embarrassing than useful in a surprise night attack by torpedo-boats. We are therefore of opinion that their place is elsewhere, and that their rôle consists, above all, in acting singly against the coasts and mobile defenses of the enemy.

The Reserve Squadron.—Though the squadron of the front line may only include vessels of recent construction, possessing the desired homogeneity of nautical power, it does not follow that the tactician should condemn the older units or units of different types. Those vessels of the second order will, with the homogeneity peculiar to themselves, constitute the reserve squadron intended to play, in time of war, a determined and considerable part. It is wrong to think that this squadron will be added with advantage to the active squadron at the opening of hostilities. More likely it would bring with it an element of weakness and embarrassment, and it will be preferable to go into action with a less numerous but homogeneous and swift force.

Moreover, the constitution of strong reserves is as necessary to a fleet as to an army, and the commander who should be willing to do without them would commit the same blunder as the general who should engage all his troops at the first shock, thus exposing himself to the risk of seeing his first check turn into a complete and irreparable rout. It is certain that the shock of the squadrons of the front lines will have but very few vessels unharmed. Victory at sea does not generally consist in occupying or keeping certain positions; it belongs to that one of the two fleets that is the least crippled in action. Only fleets of old times could, after a victory, continue their cruises or operations. Nowadays—numerous and recent examples prove it—it is very likely that victorious and vanquished alike will run back to their respective bases of operations to repair damages and refit, and will for several months to come be unable to go to sea.

Then the reserve squadrons will line up. It can be affirmed that the real victory with all its consequences will belong to the one country that will have reserved for that moment a fleet capable, after the meeting and disabling for the time being of the squadrons of the first line, to become undisputed mistress of the sea.

The Defense Fleet.—Though inferior from a tactical point of view, the reserve squadron should possess a characteristic homogeneity which alone allows it to concert on the high sea the action of its various units.

The coast-defense fleet, on the contrary, can accept and utilize vessels of the most dissimilar types. It has, in fact, to concert its action only with that of the forts and coast batteries, and requires only an insignificant nautical power. Always within call of the navy yard and its magazines of all kinds, it can incessantly renew all its supplies. The commander of the coast defense fleet is the commandant of the navy yard, who resides ashore and commands the whole of the sea and land defenses of the place. He has no other care than to utilize, according to their special capacities, the vessels placed under his orders, and which find naturally their places in the organization of *ensemble* of which we have already sketched the main outlines. Thus, for instance, he disposes of the torpedo-boats to guard the passes, protect the coast landings, pursue and harass the assailing forces, but which he will carefully avoid employing as scouting duties, for which the torpedo-boat, with its limited sight and smaller endurance, is as little adapted as possible. The real scouts of the defense fleet are the semaphores of the coast, and these can be aided by some light crafts whose duty would be to reconnoiter rapidly outside, and communicate with the signal-stations. The torpedo-destroyers will, besides, protect effectively the slow-going defense boats, obliged to remain stationed off shore.

The coast defense fleets, and particularly the mobile defenses, will incidentally lend their aid to the sea-going squadron in case of the naval action taking place near the base of operations.

The Remote Divisions.—The active squadron, the reserve squadron, and the coast-defense flotilla constitute the three necessary echelons of the properly called fighting fleet, the object of which is to maintain intact the approaches to the coasts and to gain the supremacy in the home waters. After securing this primary object, we know that the navy has another duty to perform in looking after the interests of the country over all those parts of the globe where they are threatened.

Naval operations in distant seas may be only an extension of the strife carried on in European waters between two powerful neighboring countries. In such a case both adversaries will find it to their interests to maintain near their own coasts the three echelons of their large sea-going vessels, and to send to distant stations only cruisers of great nautical power. These cruisers will be grouped with advantage in time of war into divisions of homogeneous cruisers, the duty of which shall be to protect the colonies and national commerce, as well as to attack the colonies and the commerce of the adversary. Their activity shall be exercised within determined grounds, between the limits marked by the fortified bases, where they can replenish their bunkers and secure supplies of all kinds.

Distant naval warfare presents quite a different aspect when directed against barbarous or semicivilized nations. Against natives, deprived of all means of action at sea, light-draft vessels, capable of sailing up the rivers, will do good service. They must be immediately put out of commission in case of a European war so as not to tempt the enemy with an easy triumph. When the adversary has a navy, it is clear that the fleet intended to attack it must be strong in proportion to the power of that navy, and if the contention is against real squadrons composed of modern battleships and armored cruisers, it is evident that they must be opposed by similar units in the foreign stations where naval action is intended. In this case, cruiser divisions are totally inadequate, and it is incumbent to replace them with squadrons, a thing only possible on condition that the points of support of the foreign fleet are increased proportionately to actual dockyards capable of serving as their bases of operations.

Points of Support of the Fleet.—The transformation of the old fleets lost to them in great part their independence of movements and action. It is not altogether the capital question of combustible that prevents them from remaining long at sea, and generally forces them only to move in order to go from place to place as economically as possible. The necessity of renewing their war ammunitions forces them to call at the only place where stores of these ammunitions have been established in advance. Modern vessels cannot, on the other hand, repair themselves on shores in every part of the globe. They must find the special tools required by the different pieces of their engines and their auxiliary apparatus, and the least injury to their hulls forces them to go into dry dock. Finally, their repairs in other than home docks is justly considered a violation of the laws of neutrality.

Without insisting any further, let us state that no modern fleet can do without a unique and fixed base of operations where it can run for shelter, revictual and repair, that is to say, find the special supplies and the particular implements it needs. It can be said that the navy yard forms now an integral part of the fleet; that it is its natural and indispensable complement, and in order to completely fill the part assigned to it, it should be, in the first place, a stronghold defended by land and sea against any surprise attack. Not only must the shops, wharfs, stores and refitting docks be placed beyond the range of the enemy's projectiles, the roads themselves should be strictly closed in order that the vessels anchored there may with perfect safety dismount their engines and examine their apparatus. It is on this condition alone that the dockyard is truly a support and base of operations where the fleet can find in every form the energy needed to move about and to fight.

Convoys.—The close bond existing between fleet and dockyard constitutes a tactical inferiority that must be minimized by all possible means. With this object in view, it seems in the first place an unquestionable utility to establish a great number of coaling stations in those quarters where the presumed action of the naval forces will take place. It must be stated, however, that unless these stations are fortified, they are fatally doomed to fall into the power of the enemy. The necessity of so combining the movements of the fleet as to give it a chance to take advantage of these stores, naturally impedes greatly its operations. It is likely, then, that the problem would be solved with greater certainty by the adjunction to the squadron of a supply-convoy, that is, of a convoy loaded with coal, victuals and ammunitions, with the additional duties of taking on board the sick and wounded, and, if need be, of furnishing fresh personnel or exchanging. Tempting as this idea may be, we confess that it would be well-nigh impracticable as long as the fleet has not practically obtained the supremacy of the sea. In order to avoid the risk of being captured at night by the enemy's cruisers, the vessels forming the convoy would have to be placed in the center of the fleet, and it can be easily realized that in case of surprise, this formation would be a disadvantage. On the other hand, in order not to delay the fleet, the convoy must have at least the homogeneity of nautical power of the battleships, a condition that would likely necessitate a diminution in the loads to carry. It will be always prudent to delay operations requiring the adjunction of a convoy till the hostile fleet is defeated, unless the adversary refusing general combat by squadron, it may become necessary to force it upon him by indicating a movement against his coasts with the combined forces.

The initial and dominant fact of the hostilities should be the shock of the hostile squadrons, but this shock will be always followed, if not preceded, by operations of a secondary order, as blockades or landings necessitating either convoying of supplies or transportation of bodies of troops. It will be important, therefore, to prepare beforehand the organization of these convoys for which can be employed the chartered ocean steamers, and, better still, vessels specially built and equipped for that purpose.

Independently of the properly called convoy, repair transports, hospital ships or torpedo-boat transports, will render good service to a squadron on condition of possessing a sufficiently great nautical power in order to be always able to accompany it or withdraw in time from the field of battle.

Conclusions.—It seems impossible to study the problems of naval tactics without first sketching the general outlines of a plan of *ensemble* admitting of an exact notion of what should actually compose fleets of war and of what should be required of them.

In seeking to constitute logically the forces that we will have to put in motion, we have endeavored to set off what to us seem the essential features of a modern navy, to wit, the actual antagonisms of the nautical and fighting powers, and the limited field of action of the fleets resulting from them.

No doubt but some day this antagonism will disappear. The vessel, without losing any of its fighting powers, will become swifter and swifter, and the cruiser, without any loss of nautical power, will have a more effective armament and protection.

The two factors of the tactical unit will tend more and more to merge together, and will finally constitute the unique type answering all the needs of maritime warfare. Then the fleets will become identical. The home squadrons and the foreign divisions will possess the same homogeneity and form on a single fleet capable alike, as former fleets, to operate in distant stations or on the immediate coasts of the country. It would, however, be a mistake from a tactical point of view to try to anticipate progress by a premature conception of vessels and fleets, which, in order to be adapted for every kind of service, would inevitably be actually condemned to an inferiority of one or other of their powers.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON CUBAN PORTS.

By Captain Asa Walker, U. S. N.

Cuba, from its size and situation, may well be considered the most important of the West Indian Islands. Laying aside the question of its wonderful fertility as a matter connected with the peaceful concerns of the inhabitants, it becomes necessary to investigate the possibilities that the island presents, as affording bases for hostile operations against the United States, or as locations from which to meet and ward off such attacks.

Placed at about the same distance from the peninsulas of Florida and Yucatan, it is the natural sentry-box to the Gulf of Mexico and to the waters washing the shores of Yucatan and Honduras. The nation that holds its ports, in force can, at its will, dominate over those waters and control ingress to and egress from the ports therein. The interest of the United States in the Gulf is vastly in excess of that of all other nations combined, and it behooves our country to make certain that, by no chance or oversight, any coign of vantage in Cuba be allowed to fall into the possession of a State that may antagonize those interests.

It is the object of this paper to attempt to investigate the natural facilities of the island for naval war purposes, either offensive or defensive, and to this end a critical examination of the coast and adjacent waters seems to be first in order.

From Cape Maysi, following the northern coast, there is no harbor of any magnitude or importance until the entrance to the bay, on which are situated Carbonico and Livisa, is reached. Here we find a clear entrance of 200 yards in width, which divides, at about half a mile from the mouth, into two arms leading to two separate lagoons. The eastern passage is very tortuous but clean, giving access to a lagoon having an excellent anchorage ground, of at least 5 fathoms depth, of a mile and a quarter in the east and west direction, and with a least width of 700 yards. The western passage opens into a lagoon many times broader and deeper, but much cut up with shoals. There is, however, an abundance of good anchorages for deep drafts. Both of these harbors are protected from wind and sea in all directions.

Five miles to the westward of this is the entrance to Port Nipe. This entrance has a least width of 500 yards and is clean throughout. The anchorage ground for deep drafts has an area of about six square miles, unobstructed by shoals. From the numerous rivers entering the bay, it would seem that a bountiful supply of fresh water is available. This harbor is about 90 miles, in a W.N.W. direction from Cape Maysi. It is protected from wind and sea in all directions. Between the 5-fathom and 3-fathom curves there are several square miles of clean anchorage for light-draft vessels. The depth of water in the narrow entrance, together with the strong current setting through it, would seem to preclude the placing of mines therein, though such fields would be practicable between Punta de Mangle and Punta Santa. This harbor seems exceptionally strong in a defensive sense and could be made impregnable with but a moderate outlay of labor. Batteries on the bluffs on Punta Roma, and on the south shore of the canal, would command the entrance at exceeding short range. The sole objection to Nipe as an ideal natural formation for a base arises from the narrowness of its entrance, which prohibits exit save in a contracted front. At most, but three battleships could emerge in line. The approach is well marked and access easy.

Port Banes, nine miles to the northward and westward of Nipe, presents another excellent harbor with a narrow and tortuous entrance. Its vicinity to Nipe, however, takes away from its importance, as the superiority of the latter is so marked as to dominate its neighborhood. The narrow and crooked channel would render it hazardous to attempt entrance with long ships.

Port Naranjo, about ten miles west of Sama Point, offers anchorage as a port of refuge, but presents few of the requisites of a safe and permanent anchorage for a fleet.

Port Padre, 47 miles to the westward of Sama Point, affords a secure anchorage for vessels of moderate draft. It is entered through a channel varying from one to three cables' length in breadth, and three miles long. It possesses no qualifications as a naval base, except those of security and space; the depth of water is insufficient for battleships.

From Port Padre to the westward, we find no harbors for deep-draft vessels worthy of consideration until reaching *Port Nuevitas del Principe*, which is entered through a narrow and crooked channel six miles long, opening out into a broad lagoon in which there is bountiful room for the anchorage of craft of moderate draft, but with only moderate accommodations for those of deep draft. The difficulties of the entrance would prohibit its free use for these latter.

From here to Cape Frances there are no harbors, and but one or two spots at which anchorage for small vessels is safe and secure. It is noted that *Buenavista Bay* is uncharted, but it probably resembles the other bays extending inside the line of Cays. At *Cay Frances* is found anchorage in 5 fathoms.

Sagua la Grande affords excellent and spacious anchorage to vessels of 15 feet, and is approached through the usual narrow and long entrance.

Cardenas Bay is navigable only to vessels of light draft and not exceeding 11 feet.

Port Matanzas is an indentation of the coast, some five miles deep. Opening to the northward between Point, Maya and Point Sabanilla with a width of three miles, it gradually narrows to about one mile at a mile from its end. Here is to be found the anchorage ground with shoals to seaward and restricted for vessels of deep draft; a limited area of anchorage is found outside the shoals. With its broad mouth open to all winds from the northeast quarter, the anchorages must be very unsatisfactory. Matanzas does not present features such as would recommend it to the military eye for a base. It would be impossible to mine the approach.

From Matanzas to Havana the coast runs in an almost unbroken line, yet it was here, at a point about six miles to the eastward of the Morro of Havana, that the English expedition of 1762 against Havana was disembarked. At the mouth of the

Cojimar River, three miles east of Morro Castle, the end of one of the cables connecting Havana to Key West is landed.

The *Harbor of Havana* is so well known that it need not be described. Though the anchorage space for vessels of deep draft is very constricted, so well is the harbor protected from wind and sea that close berths for ships may be safely occupied. The harbor is capable of an almost perfect defense, by means of dominating batteries and mines. The city itself lies open to bombardment from seaward.

At Chorrera harbor, four miles west of Havana, one of the cables to Key West is landed.

Port Mariel, about 20 miles to the westward of Havana, affords access and anchorage to vessels of moderate draft; a shoal part of 4 fathoms depth in the entrance, and the narrowness (50 yards) of the channel preclude its use for deep drafts. The chart would indicate a sufficiency of good anchorage for a numerous fleet.

Port Cabañas, twelve miles west of Port Mariel, offers excellent anchorage of sufficient depth and area, after passing through the entrance canal, in which is a bar with but 3¾ fathoms of water. A new survey might develop changes at this point, which might add vastly to the importance of the harbor as a port of refuge or as a base.

Port Bahia Honda has a limited area of anchorage for deep drafts and could hardly be developed into a strategic base, were its situation even the most favorable.

From Port Bahia Honda to Cape San Antonio the coast is skirted by cays and reefs, through which are occasional openings, admitting vessels of light draft to the enclosed lagoons. These latter are mostly shallow and are cut up by numerous shoals. Some few safe ports and anchorages for small vessels exist.

The lagoon immediately to the northward and eastward of Cape San Antonio seems to hold out the possibility of a good, safe and convenient anchorage for a large fleet. Should a future survey demonstrate the existence of a sufficiently deep channel through the reef in this vicinity, these enclosed waters may become of the greatest strategical importance, situated, as they are, at the extreme end of the island, whence a fleet could operate with the least delay on both coasts, and would be able to hold the Yucatan channel under the closest espionage.

From Cape Maysi to the west, on the south shore of Cuba, the first port is that of *Baitiqueri*, which admits only vessels of light draft.

Port Escondido is of small extent, though the depth of water is said to be sufficient for deep-draft vessels.

Port Guantanamo, twelve and a half miles west of Escondido, is a deep and complex indentation. Its extreme depth is about eleven miles, though the greater part of this is available for anchorage to light drafts only. The entrance to the port has a clean width of 12 cables' length, which narrows, off Fisherman's Point, to 7 cables' length. (For general description of harbor, see "Sailing Directions, Caribbean Sea, etc.," No. 86, Vol. I.) The size, situation and facilities of this port at once commend it for consideration, as a main base for naval operations connected with the islands and waters lying to the southward and eastward of Cuba. In capacity, depth and security of anchorage, and capabilities for defense and offense, it would seem to possess nearly every requisite in demand for a main station. Proper batteries erected on Windward, Fisherman's and Leeward Points would completely command the channel, and the moderate depth of water in the entrance would permit of placing any number of mines. In the middle reaches of the bay there is good and sufficient anchorage for transports and supply vessels, safe from any possible gun-fire from seaward. Numerous inlets and arms afford excellent havens for the smaller war vessels and torpedo-boats.

The port of *Santiago de Cuba* is an inlet extending nearly five miles in a general N.N.E. direction. The entrance is barely 200 yards in width at its narrowest part, gradually widening The extreme narrowness and crookedness of the channel militate against its value as a harbor for naval operations on a large scale, while they add to the ease with which it may be defended from attack. It is safe to say that the port may easily be made impregnable from the sea side.

Between Santiago de Cuba and Cape Cruz there are several points at which anchorage may be had, though of small area. At *Ensenada de Mora*, as yet unexplored, a survey may develop a safe and commodious harbor.

The entire unreliability of the charts of that portion of the coast extending from Cape Cruz 150 miles N.W., and the vagueness of the sailing directions for these waters demand a resurvey of this region, before its possibilities can in any way be predicated as to harbors for operation or refuge.

Port Xagua or *Cienfuegos* (see description, "Sailing Directions, Caribbean Sea, etc.," No. 86, Vol. I) presents many features to commend it to the attention as a safe and excellent harbor when once gained. Though having a larger area of anchorage ground than Santiago de Cuba, its long and narrow entrance channel places it in the same category, for naval purposes, as that port. It is, moreover, less easily defended by mines.

From Cienfuegos to the westward, there appears to be no deep-draft harbor, though there are many safe and extensive anchorages for light-draft vessels.

From the foregoing general survey of ports, it will be seen that Cuba, while possessing many harbors adapted to commercial use, has few that show in full the requirements demanded for a naval base. These requisites are: a sufficiently wide entrance to permit exit in strong force; a deep and protected anchorage of large extent; a capacity for ready and complete defense; and above all, a geographical location suited to strategic demands. There are several that possess two elements in an eminent degree, and but two that may be considered as presenting the four requisites combined—Nipe and Guantanamo. Unfortunately, these two ports are both situated in the eastern end of the island, about 90 and 70 miles respectively from Cape Maysi. Of the two, however, Guantanamo is by far the better, and is the one that should be selected for occupation and defense by our Government, while Nipe should be so defended as to preclude the possibility of its falling into the hands of an adversary.

Of the more western ports on the north coast, it is probable that Havana, at the moment, possesses the advantage over all others, owing to the state of its defenses, though it has very serious defects. Should a resurvey of Port Cabanas demonstrate a deep-water channel, that port would seem to afford more of the natural requisites for a fleet rendezvous, besides being better situated than Havana. The possibility of a good harbor inside the reef to the north of Cape San Antonio should not be lost sight of, since such a port would have an ideal geographical position.

The port of Cienfuegos has such excellent and secure anchorage of large extent, is so readily defended, that, though badly located strategically, except as to its position in reference to the proposed isthmian canal, its tactical merits cannot be overlooked. The channel, though narrow and tortuous, is reported as not difficult. This port should be held in sufficient force to make secure its possession to our Government.

The question of the supplies to be obtained at the various ports is one of little moment in modern warfare. It is better to consider that a fleet and occupying army must depend on their own supply-ships for all the necessaries of life.

It seems self-evident that any attack made on the United States by a European State in the future, will have for its objective our possessions and dependencies in the West Indies, and it is in those waters that the Navy will be called upon to defend the national rights and honor. It is well, therefore, to take stock of the facilities afforded by nature for the strengthening of our cause, and to make such additional improvements, in the way of fortifications, as may render such natural strongholds most secure.

With the feeble and impotent island of San Domingo lying directly between Cuba and Puerto Rico, we may confidently predict that the base for any operations against these two islands will be there established. A trumped-up claim unsatisfied can be made the pretext for an armed occupancy of any port in that island. International law and courtesy would be cast to the winds—as it has been in China—and the right of might established. It therefore behooves the United States to look the conditions square in the face and to determine to what extent preparations are to be made to meet the inevitable. With every nation in Europe suffering with a grievous attack of land famine, are not the acts of their legislatures, in increasing so enormously their navies, handwritings on the wall, needing no Daniel to interpret, foretelling that in the near future these nations will brave the woes dimly defined by the *Monroe Doctrine*, and wrestle for a slice of the rich lands of our hemisphere?

Wherever internal troubles exist and law and order are at a discount, there is a locality at which foreign intervention may be expected. When the hour comes in which we are hopelessly outclassed on the sea—and that time is approaching with rapid strides—then, we may be fully assured, will strike the hour of our country's humiliation. Vain will it be to call upon the

Shade of Monroe to protect his own. That bugaboo to foreigners will be laid beyond resurrection and we shall find that blood and treasure untold will be necessary to repair the breach in our outer walls. With Guantanamo, Nipe, Cienfuegos and Havana held in a firm grip and properly managed, we have at any moment bases ready made from which to issue in defense of national honor.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ON THE EXAMINATION OF NAVY-YARD APPRENTICES.

By HENRY G. BEYER, Surgeon U. S. N.

The government in providing an examination for applicants for positions as apprentices in the different shops of navy yards secures thereby several important objects and advantages. The mental part of such an examination, when conscientiously and properly conducted, will insure a higher degree of intelligence among the workingmen of the future and, consequently, a better quality of work in all the different departments at navy yards. The physical examination, as a means of selecting none but physically fit subjects for these positions, contributes, moreover, towards increasing very materially the value in time and money which the government invests in these boys by teaching them a trade, on account of the fact that the average life of apprentices thus selected will naturally be longer than that of the physically unfit. The method that has recently been followed out for the examination of these apprentices at the Boston Navy Yard, in accordance with Navy-yard Order No. 14, Revised, is so well adapted to the purpose and, at the same time, so far in advance of the older methods, that a brief description of it seems rather desirable, especially so as its general adoption throughout the service would seem to be as advisable as it is desirable.

Navy-yard Order No. 14, Revised, requires that each applicant shall be marked for his physical examination. As regards the physical part of an examination, there had never been any system in vogue either in the Navy or elsewhere, to my knowledge at least, by means of which a candidate was given a definite mark, expressed by a number which should count in the sum total of his entire examination, and thus be made the means of materially assisting him to get or preventing him from getting, as the case might be, the coveted position. A candidate for any position in the Navy, including that of cadet, is found either fit or unfit, is either accepted or rejected accordingly, on physical examination, without any fixed or well-defined system of marking. In the case of an examination being required, the marks obtained in the mental were the only ones that were counted. Physical excellence being so obvious a factor in the general make-up of the *personnel* of a service like the Navy, it had long since seemed to me desirable to establish some standard which should be absolutely accurate as well as calculated to give a boy credit for the physical advantages or disadvantages which he possessed in such a manner as to permanently influence his career and without doing him the least injustice. Knowing, moreover, that his physique would count in the final examination, it would serve as the very best stimulus for him to improve it whenever opportunity was favorable. This was undoubtedly the intention of the order under which Examining Boards of Navy Yards were obliged to do their work, although the more general applicability of the same principle must be clear to every one acquainted with the needs of the service. After considerable thought on the matter, it occurred to me that the best method of attaining this end was to make use of the percentile grade system and the normal growth and development tables published in the proceedings of the U. S. Naval Institute No. 74, and give each boy the proper physical percentage which, by nature and according to his age, belonged to him. One of these tables, No. XIX, for the sake of convenience is here reproduced. duced.

After this manner, a boy becomes his own physical record and takes his relative percentage position and mark without there being the slightest chance for the examiner to do him the least injustice or to favor him in any way. No mental examination can compare with it as regards accuracy of results and fairness to the individual. If, for example, the boy is superior in physique, he has advantages which it is useless for anyone, not up to his standard, to dispute him, and he should receive the necessary credit for them; if he is inferior, the boy can blame no one, except perhaps himself, for not having exercised proper care in the selection of his ancestors. No argument can change his record or mark; his own exertions alone might improve it.

Method.—The method is simple and may be briefly described as follows: A boy's age is calculated from the nearest birthday and found to be fifteen; he is now measured in the usual way and his height standing is recorded as 64.3 inches. What is his mark or height? Table XIX, finding the line of the height opposite the fifteen-year old boys, we follow it until we come to 64.29, which is the nearest to his recorded height, and the percentage number above this value will be found to be 50, which is the mark the boy is entitled to receive for his height; he is an average boy for his age. This simple process is applied in finding the percentages of any other dimension that it is desired to include in the examination by referring to the respective tables of these different dimensions. Height, weight, chest-circumference being the leading dimensions, these were the only ones made use of in the present instance. The percentage values ascertained and calculated after this manner are now added together and averaged; their average constitutes the boy's mark for his physical examination.

TABLE XIX.—HEIGHTS AND PERCENTAGES.*

Age at nearest Birthday.	Number of observations.	Values in Inches at the Following Percentile Grades.										
		5.	10.	20.	30.	40.	50.	60.	70.	80.	90.	95.
15	131	59.507	60.310	61.563	62.553	63.457	64.290	64.855	65.764	66.653	67.717	69.290
16	395	61.750	62.549	63.714	64.580	65.250	65.805	66.455	67.200	68.020	69.000	70.406
17	722	63.130	64.217	65.165	65.853	66.434	67.000	67.626	68.317	69.100	70.320	71.320
18	841	64.193	65.000	65.886	66.483	67.044	67.633	68.251	68.920	69.665	70.520	71.530
19	750	64.680	65.391	66.250	66.844	67.424	67.651	68.600	69.243	69.786	71.000	71.880
20	645	64.962	65.543	66.413	67.094	67.675	68.252	68.810	69.477	70.253	71.280	72.120
21	493	64.970	65.620	66.433	67.054	67.667	68.215	68.852	69.483	70.180	71.120	72.000
22	328	64.945	65.831	66.580	67.200	67.762	68.352	68.960	69.927	70.632	71.543	72.258
23	232	65.287	65.800	66.580	67.300	68.010	68.522	69.030	69.625	70.307	71.240	72.000

There is, however, one item which is not to be found in the percentile grade tables which must be included in the result. This item we have termed "general health," and its value is ascertained through an examination which is purely medical in character. The chief factor in this is a good heart and a good pair of lungs; a secondary factor is whether a boy approaches or not the percentile grade into which he belongs in regard to the greatest number and the most important portion of all his dimensions. A boy, for example, whose height puts him into the 75th percentile grade, but whose chest-circumference places him into the 25th percentile grade, would not be entitled to get the mathematical average of these two numbers for general health but would receive about 35 instead of 50.

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* See Beyer—U. S. Naval Inst. Proc., No. 74.

In accordance with the above-described method, eighty-five boys of an average agé of sixteen years were examined in the Boston Navy Yard about three months ago. Seventy of these boys were accepted (82 per cent) and fifteen rejected (18 per cent) by the physical examination alone. The adjoining Table I has been arranged to show the relations existing between the accepted and the rejected boys and also that which both these bear to the total number examined.

TABLE I.—AVERAGES.

AVERAGES.	*a.* THE PERCENTILE GRADES.						*b.* IN ACTUAL MEASUREMENT.					
	Age.	Height.	Weight.	Chest Circum.	General Health.	Average.	Age.	Height.	Weight.	Chest Circum.	General Health.	Average.
All 85 boys examined..	16	34	38	45	40	39	16	64.9″	112 lbs.	30.8″	40	39
The 70 boys accepted ..	16	34	40	48	42	41	16	64.9″	114 lbs.	31.″	42	41
The 15 boys rejected...	16	32	25	26	20	26	16	64.7″	106 lbs.	29.7″	20	26
Differences .	0	2	15	22	22	15	0	.2″	8 lbs.	1.3″	22	15

In explanation of the large percentage of boys that were accepted (82 per cent) it must be added that the understanding of the members of the board that the mere fact of a boy's being small in stature and light of weight should in no instance be regarded as a sufficient cause in itself alone for his rejection, inasmuch as such a boy might still be one of more than average health. In this respect it was not considered necessary to exact from navy-yard apprentices the rigid standard for strength, power and endurance that was usually required from apprentices intended for the regular Navy. Nor were color-blindness and defective vision, unless the latter was very bad, made a leading cause for rejecting a boy.

A comparison of the averages received by the accepted boys and the rejected ones, seen in Table I, shows the accepted ones to be superior in all respects to the rejected ones, but more especially so in respect to weight, chest-circumference and general health, notwithstanding the fact, which was mentioned before, that a small boy and a light boy was not necessarily rejected on account of his being light and small; consequently, many of just such boys are included in the averages obtained from the accepted ones.

The mental examination was to consist of both written and oral examinations, and include spelling and simple arithmetic, also decimals and the rule of three, 100 being considered perfect. All the boys had left school two years previously to this and engaged in various occupations since that time; they all belonged to the same class of people and lived in the closest vicinity of Charlestown.

The adjoining Table II is intended to show how the results of the combined examinations were finally calculated and to still further illustrate the simplicity of the method according to which a boy received his final mark.

TABLE II.

William B.	Mark.		Multiple.		Total.
Physical	50	×	3	=	150
Mental..........	75	×	5	=	375
Oral............	83	×	2	=	166
Total					691

Out of the seventy boys who had passed their physical examination only sixty-two presented themselves for the mental examination. One, however, being a colored boy, was omitted from my list on account of its being desirable to have the material homogeneous for the purpose of further comparison and this leaves sixty-one to be studied.

Both examinations having been completed in accordance with the above-described methods, all the sixty-one boys were arranged in a table in the order of their relative merit so that the boy having received the highest mark stood first on the list, while the boy having received the lowest number, stood at the bottom of this list. Dividing, now, the total number of sixty-one by ten, and finding the average of each section of ten, we would, of course, expect to find that the first ten presented the highest average, while the last ten would show the lowest average, at least so far as regards the column of totals.

This same result need not necessarily be expected from similar averages obtained from the column of physical marks. If, however, the physical composition of a boy has indeed any relation to his mental qualifications; if, in other words, there is such a thing as a psycho-physical relation in man, then we would expect to find, on comparing all these averages, that they all equally show a gradual decrease in values from first to last, and this, indeed, they do, as shown in Table III.

TABLE III.—TABULATED RESULT OF AVERAGES.

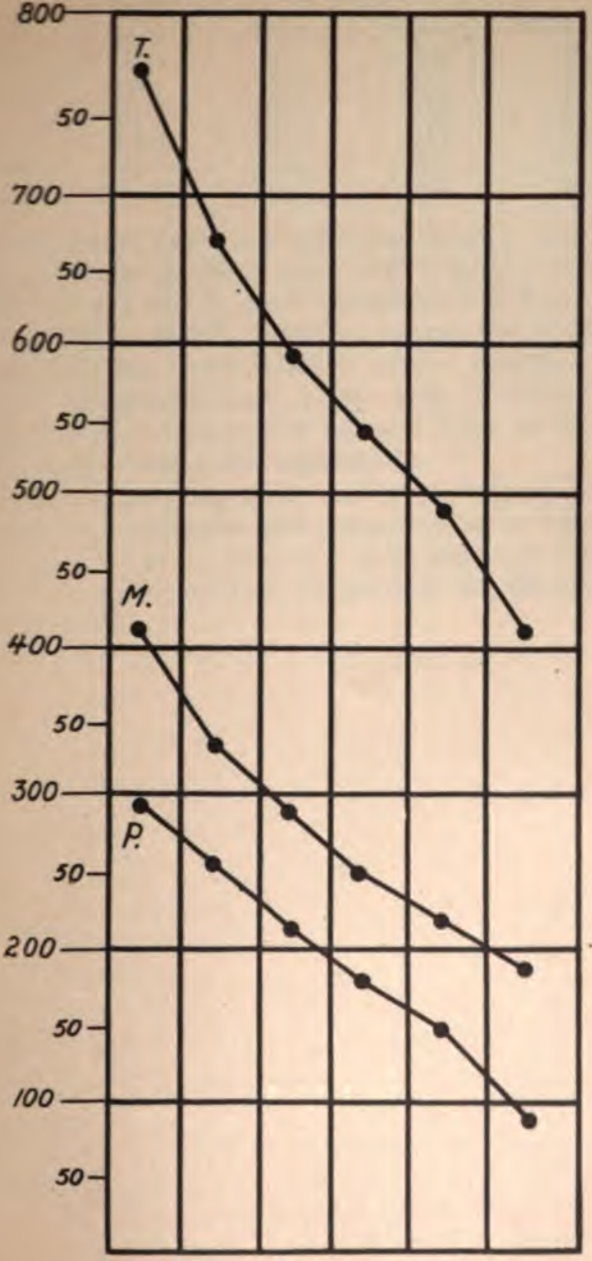
Ten.	Physical.	Mental.	Total.
1	296	415	770
2	263	332	667
3	215	297	598
4	185	255	541
5	157	222	496
6	95	191	404

The oral was not included in this table because not amounting in value to a real examination.

The adjoining curves constructed from the table show the relation existing between the averages in a still clearer light (see Plate I).

In the marks from which the physical curve was constructed are contained increments of height, weight, chest-circumference and general health. It was, therefore, of some interest and importance to ascertain whether all these four items contributed alike or whether one or the other of them contributed more than any other toward the general result. With this end in view, each of these four items was arranged in the same order as were the totals with results seen in Table IV.

PLATE I.



P = physical. M = mental. T = total.

TABLE IV.—Averages in Per cent.

Ten.	Height.	Weight.	Chest Circ.	Gen. Health.
1	55.4	64.4	64.2	53.0
2	37.4	60.4	61.5	53.0
3	38.8	39.4	49.6	45.0
4	35.5	29.2	35.8	36.0
5	27.3	31.3	41.1	37.0
6	10.0	14.0	26.0	28.0

Table IV shows there is a difference between the first ten and the last ten or eleven of 45 per cent in height, 50 per cent in weight, 38 per cent in chest-circumference and 25 per cent in general health. It will, therefore, be seen that all the items which entered the total physical mark contributed in a measure to the general result, in the order in which they are tabulated and in a manner that seems to leave no doubt with regard to their meaning and significance.

In addition to its being a new and most practical method of examining, an examination and comparison of its results have, unexpectedly, led us to discover a most important and significant relation existing between the physique and the mental performances of man.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A PROPOSED NEW METHOD OF SCORING TARGET PRACTICE IN THE NAVY.

By LIEUTENANT J. B. BLISH, U. S. Navy.

This method is based upon the *angle of error*, which is defined as follows:

Imagining—(1) a straight line passing through the rear sight of the piece and the center of the target.

(2) a vertical plane through the target at right angles to the vertical plane containing the line (1).

(3) a straight line passing through the rear sight and the point where the projectile pierces the vertical plane (2), then:

The *angle of error* is the angle at the rear sight between the lines (1) and (3).

Its tangent is the ratio of the lineal error, measured on the vertical plane (2) to the range.

Being small, angles of error may be taken as proportional to their tangents.

The minute of arc is taken as the unit angle of error. Its tangent is $\frac{3}{10000}$.

DETERMINATION OF THE ANGLE OF ERROR.

1. *By estimation.*—In subcaliber practice usually a mark floating on the water is used as a target, and the splash of each bullet shows how near it passed. In judging the distance of this splash from the target, the mind unconsciously estimates the angle of error and, knowing the range, arrives at the lineal error. It is easier, after short practice, to estimate the angle of error than to

estimate the lineal error, since the range does not have to be considered. It is also easier to estimate separately the lateral angle of error and the vertical angle of error. The whole angle of error can then be taken from the accompanying table.

These angles are estimated from the center of the splash to the center of the target, so that the size of the target is eliminated.

To assist the judgment in estimating these small angles, use can be made of the ordinary T-square, after calculating the angles subtended by the wires themselves.

In one of these instruments the distance from the eye piece to the zero wire was 34⅞ inches.

The zero wire was No. 17 B. W. G. and its thickness 0.058 inches.

This wire subtends an angle of 5.′76 at the eye piece.

The next wire on either side of the zero wire was No. 22 B. W. G. and was 0.028 inches thick.

Each of these wires subtends an angle of 2.′78.

Occasional reference to this instrument will be of assistance in estimating the small angles of error.

It may be noted that the smaller the angle, the closer its value can be estimated; the better the shooting, the more exact the score.

An instrument whereby these small angles could be accurately measured would be of great value, but with care and practice a fair and even degree of accuracy can be arrived at by estimation.

These angles are recorded in minutes (and decimals) of arc, and the corresponding angle of error, taken from the table, is recorded as the score of that shot.

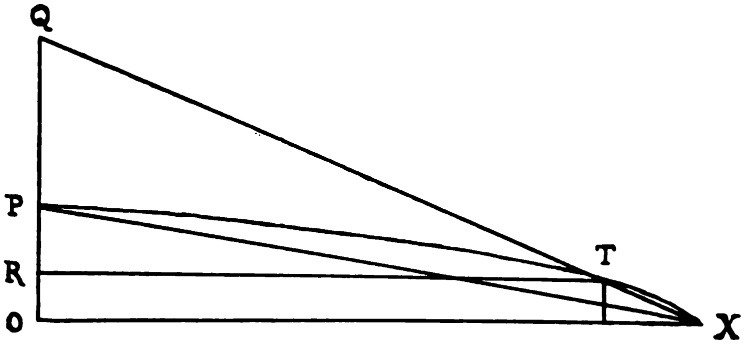
A sample page of a convenient score-book is shown opposite page 358. It is on cross-section paper of ten lines to the inch.

The error in estimating the lateral angle, due to the eye of the observer not being at the exact intersection of the lines (1) and (3), varies inversely as the range, and is practically eliminated by the observer standing close to the piece.

The error in estimating the vertical angle, due to the curve of the trajectory, increases with the range, but can be almost entirely eliminated by stationing that observer at a certain height above the piece depending upon (1) the curve of the trajectory for the range of the target, (2) the height of the piece above the water and (3) the height of the target above the water.

The height of this observer should be such that he sees the target and the splash of a bullet that has passed through the target in line.

It may be calculated approximately as follows:



Let Q represent the observer, P the piece, T the target, X the splash, OX the surface of the water, and PTX the trajectory.

$RT =$ the range.

$PR =$ the height of the gun above the target.

The angle QTP is approximately equal to the *angle of fall* of the projectile for the range RT, and is taken from the range table or measured from the drawing of the trajectory.

The angle PTR is found by

$$\tan PTR = \frac{PR}{RT} = \frac{\text{height of gun above target}}{\text{Range}}.$$

(1) $QTR = QTP + PTR.$

(2) $RQ = RT \tan QTR.$

(3) $PQ = RQ - RP.$

EXAMPLES.

U. S. S. New York.

After 8-inch turret gun firing 6 mm. subcaliber.

Height of gun above the water, 25 feet,	25
Height of flag on target above the water, 2 feet,	2
$PR =$	23

Range = 600 yards = 1800 feet.

$$\text{Tan } PTR = \frac{23}{1800}.$$

$$\text{Tan } 1' = \frac{3}{10000}.$$

$$PTR = \frac{23}{1800} \div \frac{3}{10000} = 42'.6.$$

$PTR = 42'.6.$

$QTP = 17'.4$ assumed for 6 mm. at 600 yards.

$QTR = 60'.$

$$\text{Tan } QTR = \frac{180}{10000} = \frac{18}{1000}.$$

$RT = 1800.$

$$RQ = 1800 \times \frac{18}{1000} = \frac{324}{10} = 32.4 \text{ feet.}$$

$PR =$ 23.0

$PQ =$ 9.4 feet.

Which is about the height, above the center of the bore, of the eye of an observer standing on top of the turret, so that the vertical angle of error as seen by him is not distorted.

U. S. S. Amphitrite.

1-pdr. field mount firing drill cartridge .45 subcaliber.

Height of gun above water,	7 feet.
Height of flag of target above water,	2 feet.
$PR =$	5 feet.

Range = 300 yards, = 900 feet.

$$\text{Tan } PTR = \frac{5}{900} = \frac{555}{100000}$$

$PTR = 18'.5.$

$QTP = \underline{450} = 7° 30'$ assumed for short 1-pdr. drill cartridge, caliber .45.

$QTR = 468'.5$

$$\text{Tan } QTP = \frac{468.5 \times 3}{10000} = \frac{14055}{100000}$$

$RT = 900$

$$RQ = \frac{14055}{100000} \times 900 = \frac{126495}{1000} = 127 \text{ feet.}$$

The observer of the vertical angle of error should be 127 feet above the water in order to correctly observe that angle.

TO DETERMINE THE ANGLE OF ERROR BY MEASUREMENT.

In record great-gun practice the lateral angle of error is measured on board the ship by the T-square. Usually it is not recorded closer than one-quarter of a degree, but closer approximation is possible (especially for good shooting) and more accurate work would be induced by habitually recording this angle in minutes of arc.

The horizontal fall of shots is plotted from the angles observed in the boats and, by means of the Plotting Tables, the range and bearing of the target being known, the vertical (lineal) error is found. This vertical lineal error divided by the range is the tangent of the vertical angle of error.

Thus this practice can be recorded in the same manner as subcaliber practice and in the same score-book.

In rifle and pistol practice with paper or painted targets, cross-section lines can be drawn on the targets before using and the lateral error can be noted by counting the spaces right or left from the center of the target to the bullet mark, and the vertical angle by the number of spaces above or below the center.

Knowing the width of the cross-section spaces (say 2 or 4 inches) and the range, the lateral and the vertical angles of error can be calculated and recorded, and the corresponding angle of error is found from the table.

Cross-section paper (or better yet cross-section sheeting) about a yard wide, could be purchased in rolls and cut up into targets as required; the mark or bull's eye could be painted on of such size as to best suit the arm, range, light, etc.

In *aiming drill*, after a triangle of shots is made, the real line of sight can be determined geometrically (by finding the intersection of the medial lines of the triangle) or it can be located by the instructor by sighting.

Having located the point of impact of this line, the lineal error of each shot can be found by measuring its distance from this impact. Dividing this error by the range gives the tangent of the angle of error. Note that in this case the range is measured from the target to the rear sight or to the cross-wires of a telescopic sight.

If cross-section paper is used for marking the impacts, the lateral and vertical errors are read off directly and their angles are calculated and recorded.

Torpedo practice, in which the angle of error is lateral only, can be readily scored by this method.

In each kind of practice every shot is scored by its angle of error; each string of shots by the average of the angles of error.

Practice with different classes of guns can be readily combined so that a single angle represents an absolute measure of marksmanship. Furthermore, firing at different ranges and under different conditions of roll, smoke, wind, speed of target, speed of ship, etc., can all be reduced to a common standard. This is done by a system of multiples not unlike that in use at the Naval Academy for determining class standing. To do this each class of guns, each range, and each of the various conditions under which the firings take place are assigned multiples. The angles of error are multiplied by these multiples and the sum of the products is divided by the sum of the multiples used; the resultant angle is the corrected score.

The following multiples are assigned tentatively:

GUN MULTIPLES.

Class.	*Gun.*	*Multiple.*
a	Pistol,	1
b	6 mm., on shore,	3
c	6 mm., afloat,	4
d	Boat gun,	2
e	Secondary battery,	5
f	Main battery, new R. F. mounts,	7
g	Main battery,	8
h	Main battery, turrets,	10

EXAMPLE.

William Jones (Cox.):—

Gun.	*Score.*	*Multiple.*	*Product.*	*Final.*
a	3.0	1	3.0	
c	2.5	4	10.0	
e	3.0	5	15.0	
g	5.0	8	40.0	
		18	68.0	= 3.78

John Brown (G. C., 1 Cl.):—

b	2.0	3	6.0		
d	2.5	2	5.0		
f	4.0	7	28.0		
h	10.0	10	100.0		
		22	139.0	=	6.32

RANGE MULTIPLES.

Range.	*Multiple.*
Close range,	2
Fighting range,	4
Long range,	5

EXAMPLE.

William Jones (Cox.):— Fired two strings of shots from a 6 mm.

	Score.	*Range.*		*Multiple.*	*Product.*	*Final.*
1st string,	2.8	Close,	(100 yds.)	2	5.6	
2d string,	3.5	Fighting,	(600 yds.)	4	14.0	
				6	19.6	= 3.37

TARGET MULTIPLES.

Class.	*Target.*	*Ship.*	*Multiples.*
a	Fixed.	At anchor.	1
b	Towed astern.	Under way.	3
c	Towed by steamer.	At anchor.	4
d	Towed by another ship.	Under way.	6

CONDITION MULTIPLES.

Class.	*Wind, smoke, roll, light, etc.*	*Multiples.*
a	Good.	1
b	Fair.	2
c	Bad.	4

These data (and others, if desired) are noted in the score-book and can be made use of at any time to compare different scores.

Time allowance multiples for each class of gun can also be assigned.

There seems to be no simple solution to the problems of indicating in the score (1) the number of shots from which it is made up, and (2) the number of different classes of guns that were fired in making up a man's score.

The question of assigning different multiples to the horizontal and to the vertical angles in computing the total angle of error, instead of combining them with equal weights as is done in the table, is one of such importance that it would seem best to leave it open for the present. To the end of arriving at the best solution of that problem, it would be well always to record both of these angles and preserve the records for study.

It is believed that this method of scoring presents the following advantages :—

(1) It is simple and easily understood.

(2) It measures skill in marksmanship.

(3) It measures the improvement due to instruction, practice, desire to improve, etc.

(4) The skill of two or more men, guns' crews, divisions, ships or squadrons, can be compared for the purpose of fostering the spirit of competition.

(5) Scores can be compared to a standard for awarding prizes, etc.

(6) Scores with different arms can be compared.

(7) It furnishes data for representation and study of the efficiency of gun fire.

RECAPITULATION.

By this method, each shot is scored by a number representing the angle of error expressed in minutes of arc.

The score for a string of shots is the average of the separate shots of the string.

The score for a gun's crew, division, ship or squadron is likewise the average of the individual scores.

Perfection is represented by zero.

Some difficulty may be encountered in teaching some men that good shooting is represented by a small score, but a short dissertation on the subject, accompanied by practical illustration at aiming drill, ought soon to overcome this.

Cross-section paper or small slates with cross-section lines scratched on them could be furnished the men on which to plot their scores; each space representing one minute of angle of error.

To combine scores made under different conditions, at different ranges, with different classes of guns, etc., and to take account of time allowances, a system of multiples is made use of, but the corrected score always remains an angle (expressed in minutes of arc).

In conclusion, the following suggestions regarding subcaliber practice (for the originality of which no claim is made) are offered.

(1) Since the Army caliber is to replace the Navy 6 mm., that the 6 mm. rifle be issued for subcaliber practice.

. Among the advantages of this are:

Its high velocity permits the use of the full charge side of the sight bar, without allowance (or nearly so).

The absence of smoke, dirt, and the annoying report of black powder cartridges.

The bullet is not apt to ricochet on water (I have never known an instance.)

The splash is almost, if not as plainly seen as that of the .45 caliber.

Owing to its flat trajectory, the splash of the bullet as seen by the man who fired it marks the angle of error with very little distortion.

(2) That this rifle be fitted to all guns of the secondary battery (including boat guns) and main battery. In the former the rifle could well be fitted outside of the barrel; its easy recoil not necessitating very strong fittings. All of these fittings can be readily made on board ship until the regular ones are issued.

(3) That subcaliber practice be made a daily routine whenever possible. At sea in company with other vessels, targets can be towed by each ship for another to fire at. A single vessel can practice at a target towing astern. In port, where the great range of this gun might render this practice dangerous, a certain number of these rifles might have the barrels sawed off for the purpose of reducing the initial velocity of the bullets. While this would sacrifice the advantages of a flat trajectory, the other good points of the rifle for this purpose would be retained.

(4) That standard score-books be issued; the leaves to be cross-section paper (ruled on both sides) and replaced when necessary from paper kept in store.

DISCUSSION.

Lieutenant J. H. GLENNON, U. S. N.—In connection with this system of recording target practice, the use of a telescope or tube with a number of cross wires seems to recommend itself. The center pair of wires, or the center of the field of view of telescope or tube, should of course be plainly marked. An observer with the telescope or tube notes the intersection of wires on which the shot hits, the center being on the target. If now a similar telescope or tube is used as a gun-sight, and if the observer is in the line of fall of the projectile, as proposed by Lieutenant Blish, the intersection as seen by the observer may be used in the gun-sight in place of the center, and the shots should go true. For example, the observer sings out 2 right 3 down, referring to the divisions of his instrument. The gun-pointer brings 2 right 3 down on the target for the next shot. Succeeding points for the target should of course be placed relatively in each case to the one preceding. It would be necessary to have one set of wires horizontal or nearly so in the observer's instrument, and therefore he should occasionally bring it on the horizon for verification.

This method conforms to the marksman's rule, after getting a shot on a target, of changing his point of aim in place of changing the sight. In ordinary direct fire it is not necessary for the observer to get exactly in the line of fall. It is more important generally that he be directly above the gun; this will enable the correction for speed, wind, etc., to be made.

BROWN, JOHN. (G.C. 1 CL.)

No	Time.	Horiz.	Vert.	Score	8 in Turret
1		25	10	27	6 M/M Sub.
2		5	10	11	
3		0	0	0	4. 500 Yds.
4		5	5	7	
5	105	0	5	5	Target C
5	105	35	30	50	
	21	7	6	100	Condition A.

SMITH, G. W. (MESS ATT.)

No	Time	Horiz.	Vert	Score	Revolver
1		10	0	10	30 Yds.
		8	4	9	
		0	13	13	Target A
		12	5	12	Condition A
		3	0	3	
6	95	20	5	21	Train Sta.
6	95	55	225	68	Newport
	16	89	[illegible]	133	

DILLON, JOHN (LDS.)

No	Right	Left	Short	Over	Score
1	15		35		38
2		5		45	45
3		0	15		15
	15	5	50	45	98
	15	3	25	45	327

AIMING DRILL 4 IN R.F.

37 FT CONDITION A.

LIEUT. JONES.

No	Right	Left	Score
1	10		10
2		25	25
2			25
	10	25	175

18 IN WHITEHEAD
OBRY.
950 YDS.
TARGET C
SPEED 8.5
CONDITION B

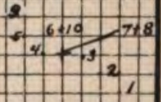
OFF BLOCK ID. July 10/00.

NAVAL CADET BANKS.

No	Time	Right	Left	Short	Over	Score.
1	00	2		1		22
2		1		5		11
3			5	0		5
4			5	0		5
5	75		1		5	11
6	150		5		5	7
7			0		0	0
8			0		0	0
9			1		1	14
10	250		5		5	7
10	250	35	35	15	25	82
	25	12	6	4	4	082

6 M/M
100 YDS.

STANDING.
CALM.
SHEETING TARGET.
CONDITION A
KEY WEST
MARCH 9.

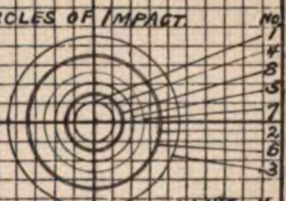


1 LINE = 0.5

NO. 11 6 PDR. CREW. AIMING DRILL

No	Name	Rate	Class	Score	
1	BROWN, WM.	COX.		100	
2	JONES, T.	SEA.		332	6 PDR
3	SMITH, R.	LDS.		450	D-5.
4	JOHNSON, C.B.	APP.	1 CL.	150	
5	ALLEN, M.	APP.	2 CL.	200	41 FT.
6	ANDERSON, N	MAC.	3 CL.	345	
7	LARSEN, O	O.S.		258	AT SEA
8	KENNEY, G	BUG.		154	
8				1989	CONDITION
				249	A

CIRCLES OF IMPACT.



1 LINE = 1'

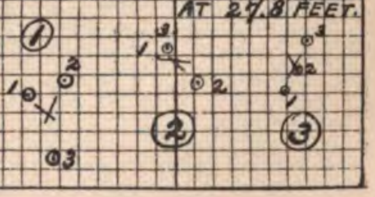
THOMPSON, T. (LDS.) AIMING 6 M/M

No	Score	Score	Score
1	13	13	13
2	19	16	3
3	23	13	16
3	55	44	32
	293	147	107
	147		
	107		
	437		
	146		

AT ANCHOR

CONDITION B.

THOMPSON'S TRIANGLES
AT 27.8 FEET.



ROR	CO
7.5	8.
7.5	8
7.6	8
7.7	8
7.8	8
7.9	8
8.1	8
8.3	8
8.5	9
8.7	9
9.0	9
9.3	9
9.6	10
9.9	10
10	11
11	11
11	11
11	12
12	12
12	12
12	13
13	13
14	14
15	15
16	16
17	17
18	18
19	19
19	20
20	21
21	22
22	22
23	23
24	24
26	26
26	26
27	27
28	28
29	29
30	30
31	31
33	33
35	35
37	37
39	39
41	41
46	46
51	51
..	60
..	.

DISCUSSION.

TORPEDO CRAFT: TYPES AND EMPLOYMENT.

(*Discussion continued from No. 93.*)

Lieutenant R. H. JACKSON, U. S. N.—In replying to the discussions upon this article, I will briefly note the opinions which are diverse.

Commander Drake advocates a destroyer between 1000 and 2000 tons displacement, 25 knots, armed with a powerful battery of light guns; he also places torpedoes on this vessel. She should also have a large coal capacity. We have now an excellent scout and despatch vessel; but the need of her torpedo armament has now disappeared, as she is debarred by her size from attempting a surprise attack as a torpedo-boat.

Lieutenant R. C. Smith advocates a somewhat similar vessel with a small battery and no torpedoes, and calls her a despatch-boat; he creates this type to prevent the misuse of the torpedo-destroyer and boat. The Mayflower was the nearest vessel to this type during the war, but did not possess the speed. She was, however, an exceedingly useful vessel.

Although a machine gun was advocated for the Giom type only, it could be employed with advantage on the other types of boats against exposed crews of other boats or troops ashore.

I do not think the practical utility of a low-power shell gun advocated by Commander Kimball would be demonstrated under service conditions.

Lieutenant Chandler's armament of two 14-pdrs. and six 6-pdrs. automatic would make a very heavy battery. I do not think the after 14-pdr. an essential at any rate, a bow-chaser being sufficient.

An error is claimed in the present number of the Proceedings, referring to the performance of the Dupont. My statement of her mileage was obtained from one of her officers who had worked it out. I find that it should have been approximately 12,000 miles, if counted from her commission till her date of sailing north after the war.

As I am heartily in favor of this type, I take pleasure in so improving her record.

The steering engine of torpedo-boats of all types should be placed in the engine-room. They have been so placed in a few boats, and in many vessels of greater displacement. The efficiency of the engine and the comfort of the crew are increased, and the engine is less liable to be disabled by a shot.

Lieutenant SPENCER S. WOOD, U. S. N.—I regret extremely that this paper did not reach me until March 17th, too late to present my remarks upon it, and that I am too busy even now to give it the attention which it merits. The subject of torpedo craft and their uses is very near my heart, and I would gladly go deeper into the discussion had I the time, but I cannot let the statements made on page 11, at the bottom, in regard to the performance of the Dupont go unchallenged. I fear Mr. Jackson has not looked into the facts of the case closely enough or he would not have rendered himself liable to such errors.

The Dupont accompanied the fleet when it sailed to Havana on April 22, and the following day, when on the blockade off Matanzas, remaining there until the 27th, when she returned to Key West for coal, leaving there at 8 A. M. of the 29th to resume blockading station. On May 7 again returned to Key West for coal, where she was detained until the 16th for despatch duty, but on that day she was sent to meet the fleet in the Old Bahama Channel. After delivering the despatches, she returned to Key West, arriving at 5 P. M. on May 18. On the 20th, at 8 A. M., the Dupont left Key West to carry despatches for the Flying Squadron off Cienfuegos. She did not accompany "a squadron to Cienfuegos," but made the run alone and unaided. She remained with that squadron on the blockade and patrol duty until May 24, when she was sent to Key West with despatches. She then had to go to Mobile, Ala., for repairs, not to engines and boilers, but to her hull, caused when coaling from the Iowa. She had to remain at Mobile until June 15, and then returned to Key West, when she was sent to overtake the convoy bound for Santiago. After June 16 the Dupont did not again see Key West, but remained on duty with the fleet on the south coast of Cuba. She always was ready to take not only her turn, but also that of some of the other boats on the patrol off Santiago, and she made runs which surely might be called long runs to Cienfuegos and Port Nipe and return from Guantanamo. She also ran from Guantanamo to the place the Colon ran on shore on July 3 and back to Siboney with the official report.

As to her record for steaming, I am more than sorry that I have not the actual figures here at hand, but they are on file in the Bureau of Navigation, and if I am not very much mistaken, her mileage during the war will exceed 12,000 miles, and this was from actual records on board the Dupont when the report was made. All the repairs which were made on the Dupont, with the exceptions of those on the hull mentioned above, were made by the force on board. With the exception of the enforced delay at Mobile, she never refused duty from not being ready for service, and I would gladly have the matter referred to Commander W. W. Kimball as to which of the two boats mentioned by Mr. Jackson was more often ready for duty.

I cannot agree with Mr. Jackson in his opinion that "the record for staunchness, sea-keeping power, and general excellence belongs to the Porter, which held the record of 12,900 miles of war service, on despatch and blockade duty without repairs other than those made by the force on board." I am convinced that an unprejudiced opinion, based on an examination of the logs of the two vessels, will show that the Dupont made fully as good a showing in every way as did the Porter; and furthermore—a fact which seems to have been overlooked in many cases—she came back home in fully as good a condition as when she left as far as her engines and boilers were concerned. Only slight repairs were required, while the Porter needed new boilers. It is an error to think or argue that because the Porter needed new boilers and the Dupont did not, that the former boat made more miles or saw more severe service during the war. I might quote other boats which broke down early and often, but no one ever suggested it was because they had performed any great amount of service.

I claim that Mr. Jackson's statements are unjust to the record of the Dupont and are not borne out by the facts, and I might add that I am basing my statements from notes taken on board the Dupont the days that the events occurred; I am not relying on my memory or on hearsay, but from actual written notes which I have in my possession. If I am not very much mistaken, the Porter sailed from Guantanamo on July 10 instead of the 20th, as stated by Mr. Jackson; at any rate, she received her orders to leave on July 9, while the Dupont remained doing duty until August 3. True the Porter did go to Puerto Rico and the Dupont did not, but the latter was rolling on the blockade off Cuba during that time, which duty was fully as trying without the excitement to relieve it which fell to the share of the Porter. I do not want any one to think that I am attempting to belittle the splendid work done by the Porter, but I do ask justice for that done by the Dupont and her crew, and again I challenge the statement that the Porter is entitled to hold the record.

I hope in the near future to be able to submit to the Institute the record of the Dupont while under my command, and I trust that the other officers of the torpedo-boats will do the same, so that the service at large may see the work performed by these boats in war times.

PROFESSIONAL NOTES.

SHIPPING AND SHIPBUILDING IN THE UNITED STATES.

By James W. Ross.

Notwithstanding restrictions, shipping continued to grow in spite of all efforts on the part of mother country to the contrary, and at the time of the outbreak of the Revolution shipbuilding was the leading industry in New England. During the eight years from 1788 to 1797 shipping increased three hundred and eighty-four per cent, but this remarkable increase was exceptional, and was due to the almost universal state of war existing in Europe at that time which threw the carrying trade of the world into our hands. From 1807 to 1837 was a period of decrease in our shipping, and was followed by a second great rising period culminating in 1861, when the maximum tonnage of the United States at any one time in its history was reached, being at that time 5,539,843 tons, while that of Great Britain was 5,895,369, and the combined tonnage of all other nations, at that time, amounted to 5,800,967 tons. The aggregate tonnage of the United States in 1861 was, therefore, but little smaller than that belonging to Great Britain, and being less than 300,000 tons smaller than that of the rest of the world.

The following table, taken from the report of the Commissioners of Navigation and the records of the Treasury Department shows the rise and fall of American shipping during the last one hundred years:

Year.	Tons.	Per Cent.
1790	346,254	40.5
1795	529,471	90.0
1800	657,107	89.0
1805	744,224	91.0
1810	981,019	91.5
1815	854,295	74.0
1825	665,409	92.3
1835	588,173	84.5
1845	904,476	81.7
1855	2,348,358	75.6
1865	1,518,350	27.7
1875	1,515,598	26.1
1885	1,262,814	15.3
1895	822,347	11.7

The above statistics show to what a great extent our shipping has fallen off, particularly since 1861, when our foreign tonnage reached its highest point, until, in 1895, it was but little more than one-third as great as in 1861, and over 150,000 tons less than it was eighty-five years before, or in 1810. This startling decline is shown still more clearly when we compare the per cent of imports and exports carried by our vessels. Our ships having carried 91.5 per cent of our foreign trade in 1810, and but 11.7 per cent in 1895, or a falling off of about 80 per cent. While that of Great Britain, in 1880, was 6,574,513 tons registered. The aggregate British tonnage being somewhat over 16,000,000.

Our entire tonnage, both sail and steam, decreased from 5,539,813 tons, in 1861, to 4,057,734, in 1881, and 4,769,020, in 1897, showing a considerable fall for the first twenty years, followed by a slight increase thereafter. Iron steam vessels having slightly increased in total tonnage since 1861, while there has been a slight decrease in the aggregate tonnage in sailing ships for the same period.

The vessels built in the United States since 1880, in tons, are as follows:

Year.	Tons.
1855	583,450
1860	233,194
1880	157,409
1882	282,269
1886	95,453
1891	369,302
1895	111,602
1897	232,232

In 1856, the tonnage built in Great Britain was 935,000 tons, and in 1880 it had reached 7,903,000 tons, or nearly nine times as great as in 1856, while that of the United States for the same period was but little more than one-fourth as great as in 1855. The tonnage of iron vessels built in the United States from 1876 to 1881 was 127,298 tons, that of Great Britain over 2,000,000 tons. Of the tonnage built in 1897, 124,394 were of iron and steel.

The total tonnage of all vessels, foreign and domestic, entering our ports in 1870 was 6,270,198 tons, and in 1897 had increased to 20,002,639 tons, of which but 3,611,176 tons were American. These figures, of course, do not include our tonnage on the lakes and rivers of the United States, but merely those vessels engaged in ocean commerce.

The total tonnage built on the Great Lakes since 1880 was:

Year.	Tons.
1880	22,899
1881	73,504
1886	20,400
1891	11,856
1895	36,353
1896	108,782
1897	116,937

Of the total carrying-power of the world, 3.4 per cent is carried in American ships, while British ships carry 56.6 per cent. The newspapers of Hamburg, the third largest commercial port in the world, said, in 1897, that thirty years had elapsed since that port had seen the stars and stripes at a masthead. No merchant ship flying the United States flag passed through the Straits of Gibraltar or the Suez Canal in 1895 or 1898.

It is only in the deep sea navigation, across the ocean or to South American ports below the Orinoco, that our shipping interests are weak. American ships carry now about one-half of the total sea commerce between the United States and neighboring foreign countries, as Canada, the West Indies, Mexico, Central America, and the northern coast of South America. Our domestic water commerce, coastwise, Great Lakes, rivers and canals, is by far the largest in the world and is two and one-half times greater than that of the United Kingdom, second on the list.

The primary cause of the decay of shipping and shipbuilding may be termed a natural one, the result of the progress of civilization; namely, the substitution of iron and steel for wood, and steam for sail as a means of propulsion. So long as ships were built of wood we had an advantage over other nations, in the cost of material and in the skill and working of the same, and also in the skill of managing wooden sailing ships; when, however, steam was substituted for sail and iron for wood, these advantages were in a great measure neutralized or wholly swept away.

Another cause put forth for the falling off of American shipping and shipbuilding is the duties on shipbuilding material in the United States and the navigation laws. It is true that the navigation laws were enforced at the time of our greatest importance in the shipping world during the early part of the present century, but at the same time all other maritime nations had similar codes, which have since been repealed or greatly modified, except in the case of the United States. From 1816 to 1840, the shipping of Great Britain remained almost stationary, but when duties were removed it increased immediately, and still more so when the navigation laws were repealed in 1849. Another cause for the decline in shipping is said to be the excessive fees charged ships entering the United States ports for pilotage, health fees, tonnage duties, etc., which amount to a great part of their revenues.

On the other hand, there are those who take the opposite view of the case and argue that the navigation laws and duties on ship materials were the very cause of our prosperous shipping trade at the beginning of the present century, and that as soon as these were all modified, as in the case of the reciprocity laws, our trade fell off. On the whole, though, it seems more probable that the falling off in our shipping was not greatly affected by these measures, either one way or the other, and that the chief causes of the decline were the changes that took place in shipbuilding, thus throwing the advantage of skill and cheapness of production into the hands of the British, who were better able to use the new materials than we were.

For over a century and a half shipbuilding in the United States was limited to the construction of wooden vessels, and their sole means of propulsion was by the use of sails. But the beginning of the nineteenth century was destined to make the first great change in shipbuilding in this country, for with its coming came the introduction of the steam engine as a new means of propulsion. This new and wonderful motive power was first successfully applied to ships in this country by Robert Fulton, whose Claremont, built in 1807, was the first successful steamboat in the world. The Claremont was a side-wheel steamer, 133 feet long, and it is said to have attained a speed of five miles per hour on her trial trip from New York to Albany. The following years were marked by the building of a number of other steamboats of a similar type, most of which were employed on the Hudson River, between New York and Albany. In 1814 appeared the first steam warship ever constructed. This vessel, built by Robert Fulton, and known as the Demologos, was constructed in 1814, and consisted of two hulls joined together with a canal in the center for the paddle-wheel, and is said to have steamed at the rate of five miles and a half per hour. The Demologos was never used in battle and her value as a fighting ship was, therefore, never ascertained.

The first steamship to cross the Atlantic was the Savannah, built in New York in 1819, and crossing from Savannah to Liverpool in twenty-five days. This trip, however, was not accomplished entirely by the use of steam, for the Savannah was also fitted with sails and the paddle-wheels were so arranged as to be folded on deck during favorable winds and the sails used, so that steam was employed only during weather unfavorable for the use of sails.

The great drawback at this time for the use of steam as the sole motive power was the great amount of fuel necessary to carry a vessel across the Atlantic, it having been estimated that more than four times as much coal was necessary to each horse-power as is required now; for this reason it was many years before steamships were sufficiently perfected to make it possible for them to cross the ocean under steam power alone. The Great Western, a British ship, making the first trip in 1878, from Bristol to New York, in fifteen days.

American steam shipping, however, did not assume any great proportion until 1848, but from that time it increased so rapidly that in 1851 it was practically equal to that of Great Britain. In 1850, the first American line of steamships to compete in the transatlantic trade known as the Collins' Line was established. Four ships were built, the Arctic, Baltic, Atlantic and Pacific, being larger and swifter than any other ships afloat and having vertical bows, the first of the kind ever built. For a time this line was the finest in the world, but disaster seemed to follow the company, two of their ships being sunk, one of which was never heard of again after starting on her trip across the Atlantic. Some few years later the company failed.

Meanwhile other great changes had come about in the construction of ships; namely, the use of iron instead of wood. In 1834, the John Randolph, built in England for a Savannah man, was the first iron ship ever seen in the United States, although the first vessel to be constructed of this material is said to have been built in Great Britain in 1818. The first large vessel to be constructed of iron was the British ship Great Britain, built in 1843, and was also fitted with a screw propeller, being the first ship of large size in which the screw had ever been used, although first introduced by John Ericsson in 1836.

The next important change in shipbuilding came with the introduction of the compound engine or the old-fashioned low-pressure jet-injecting type. With the old form of engine the great drawback to high speed was the great amount of coal required per horse-power, and the impossibility of high pressure. The compound engine, to a great extent, changed these conditions, and together with the advancement in boiler-making, made a much higher pressure possible, with a great saving in the amount of coal required per horse-power; it having been said that but 2½ pounds were now required for each horse-power where 4 had been necessary with the old form of engine, the compound engine was used in 1862, by the Cunard Line of steamships, and came into general use in 1874, when it was introduced into the ships of the Inman and White Star companies.

But at about the same time the compound engine came into general use, a still greater improvement made its appearance in the triple-expansion engine. This new type was first used in 1874, but did not come to be generally adopted until about 1885. With its introduction came a still greater development of speed in steamships, owing to the higher pressure and to the further saving of coal, which was said to be as much as 20 to 25 per cent less than the compound engine required. This wonderful improvement was followed a few years later by the quadruple-expansion engine, making a still greater saving in the consumption of coal, at the same time making higher pressure possible, and, hence, greater speed. The St. Louis and St. Paul, our two fast liners, are fitted with these engines, the first large ships to which the new principle has been applied.

Steel came to be used in ship-construction about 1880, although not very generally adopted until some years later. Its introduction brought about a still greater improvement in shipbuilding, owing to the fact of its greater strength than is possessed by iron, hence a ship may, by its use, be made lighter and at the same time stronger than by the use of iron. Steel has not been used until within the last few years for the construction of merchant ships, but has been used almost from the time of its adoption, in 1880, in the construction of our ships of war.

Twin screws first came into general use in 1887, when the City of New York and the City of Paris were built for the Inman Line Steamship Company, and soon after the same principle was applied successfully to the White Star Line steamships Teutonic and Majestic.

The system of multiple screws was still further enlarged upon about three years later, with the introduction of the third screw. This arrangement has been successfully carried out in the Columbia and the Minneapolis, our two fast cruisers, and driven by three 3-cylinder vertical inverted, triple-expansion engines, attain speeds of 22.81 and 23.073 knots per hour respectively on four-hour runs. The fastest time ever made by a cruiser.

The special advantage of triple screws are, smaller size of the separate parts of the machinery, enabling higher rotative speeds to be employed with safety, and greater economy than ordinary cruising when one engine working up to about its natural draft full power will give a fair cruising speed with economy of fuel. It is far from economical to run large twin-screw engines designed for nineteen knots and upward at speeds of nine and ten knots. Engine friction alone forms such a large percentage of the power developed, to say nothing of the increased cylinder condensation due to the slower rotative speed, that the economic performance, as measured by coal per horse-power, is very low. The total horse-power being divided between three shafts also vastly decreases the chances of the total disablement of the ship.

In 1892 a bill was passed by Congress, at the proposal of Dr. Griscom, president of the International Navigation Company, admitting the New York and Paris to American registry on the understanding that two other ships of at least equal tonnage would be built in the United States. The two ships built according to the provision of this act, the St. Louis and St. Paul, were launched in 1895. A short description of them may serve to show the state of advancement in shipbuilding in the United States, and further as an illustration of the most recent improvements in ship-construction.

St. Louis and St. Paul are the largest ships ever built in the United States, and, with but few exceptions, the largest and most powerful of any ships in existence. These vessels are sister ships, 545 feet in length, 62 feet and 9 inches beam, and 42 feet and 4 inches deep, with a light displacement of 10,700 tons. The motive power is furnished by a pair of vertical inverted quadruple-expansion engines actuating twin screws, to carry a working steam pressure of two hundred pounds, and capable of developing 20,000 indicated horse-power. The ships themselves are built of steel, and every bit of material used in them is of domestic production. They are of American model and design, and were built by American skill and muscle.

When the act of admitting the New York and Paris to American registry, on condition of building two ships of equal tonnage in American shipyards, was passed, the British press ridiculed the idea. "Such ships could not be built in the States," they said; later certain naval architects from Great Britain visited our shipyards and saw such ships actually in process of construction. Now the British newspapers admit that our yards are capable of turning out ships equal to the product of any shipyard in the world.

St. Louis and St. Paul have proved to be all that was expected of them; safe, commodious, comfortable, luxurious and fast; free from vibration and among the stanchest and ablest sea-boats afloat. A striking incident of the latter quality occurred in a recent passage, when the St. Louis and Campania, being abreast in a gale heavy enough to buffet and knock down the speed of the latter, the St. Louis plunged through it at nearly full speed without the slightest distress or discomfort.

The St. Louis and St. Paul have taken the passage record from New York to Southampton, St. Paul holding the westward record of six days thirty-one minutes, and the St. Louis the eastern record in six days ten hours and ten minutes.

Having thus proven our ability to compete in the construction of passenger vessels with our British cousins across the Atlantic, let us now see how our ships of war compare with theirs. It has been but a few years since what is known as the reconstruction of our navy began. In 1882, the first of our present new navy, the Atlanta, Boston, Chicago and Dophin were, by Congress, authorized to be constructed. Since that time we have added over forty vessels of modern type, and with but few exceptions built of American material and by American workmen, and from American designs. We have now reached a point where we are able to compete successfully with any nation in the world, and, in fact, our ships are said by many to be superior to those built in British shipyards.

An eminent English naval authority, in an article published in *The Fortnightly Review*, July, 1894, compares our battleships of the Indiana class with similar ships in the British and French navies, and, after noting the size, speed and armor, says:

"It will be observed that the Indiana and Iowa compare unfavorably in speed with both Renown and the Jaureguiberry, but in almost every respect they seem to be immensely, nay, crushingly superior; and I do not regard great speed of supreme importance in a battleship. What, for example, could be the value in practice of the Renown's superior speed as against the Indiana's? It might, it is true, enable our ship to force an action, but with an opponent so greatly superior in gun-fire our ship could scarcely hope, other things being equal, to achieve success.

"If the two ships, engaged bow to bow, stern to stern, or bow to stern, the United States ships could give blows much more numerous than those of the British ship, and in the aggregate nearly thrice as heavy; even if they engaged broadside to broadside the aggregate energy of the American fire would be much more than double that of the British. Put our huge Royal Sovereign or our coming Prince George, as our champion instead of our Renown, and we will not fare much better, for the Americans distribute their guns much more advantageously than we do, and their battleships, which I have sighted, represent more sensible compromise of the rival claims of speed, radius of action, gun-power and armor than any of ours. If our battleships be unequal to the task of engaging another battleship of inferior displacement, superior speed will avail the former little, unless to enable her to run out of danger; yet, is not the main object of a battleship after all to fight? In the war of 1812 we were obliged, much against our will, to take lessons from the United

States on the subject of the proper way of gunning frigates. We might do worse now than take lessons from the United States on the subject of the proper way of gunning battleships; and, also, of gunning cruisers, for the American cruisers are as superior to ours as the American battleships are."

The chief cause, as we have seen, of the decline of our shipbuilding industry was the change from wooden to iron ships, thus throwing whatever advantage there had been in our favor into the hands of Great Britain, owing to the fact that the latter country was better able, at that time, to produce iron, and could do so more cheaply than was possible in the United States. But we have made such rapid progress in the iron industry during the last few years that we are no longer at a disadvantage in this respect, but, in fact, are able to produce iron and steel cheaper than it can be produced in Great Britain. We have not yet reached our maximum power in the production of iron. Our furnaces are much larger than those in Great Britain and of a more modern type, and with the vast amount of iron to be found in the United States, and the large amount of capital which may be employed in the iron industry, there seems to be no reason why we should not continue to produce iron and steel at the same, if not at lower, rates than is possible in Great Britain. Another advantage we have is the cheapness of fuel. American coal is the cheapest in the world. The cost of production has generally decreased during the last few years. In 1880, the average annual output per employee was 190 tons; it is now about 550 tons. In 1882, the output of pig iron was 4,623,323 tons, and of finished iron and steel 3,500,000 tons. In 1887, these figures had reached 6,417,148 and 5,250,000 tons respectively, while in 1897 these figures were 9,652,680 and 7,000,000 tons.

American steel rails are now being supplied on contracts to British India, Russian Asia, and the West Indies, Canada, South Africa, Hawaii, and even to Ireland. In one month last year the two largest steel rail companies are said to have booked between them no less than a half-million tons, the largest proportion of which was for export. Nor is this surprising, for the prices have steadily fallen during the last few years; thus, in 1896, the price of steel rails was $24.25 a ton in the United States, $26.80 in Germany, and $23.75 in Great Britain.

In 1898, the prices were $19.00 in the United States, and $28.75 in Germany, and $22.50 in Great Britain. In 1898, the exports of iron and steel from the United States amounted to $70,367,527 as against $57,497,872 in the previous year.

The *London Statist*, one of the principal financial journals of England, published not long ago, an article entitled "American Ships, Iron and Steel," in which, after dwelling at some length upon the rapid development of our iron industries during the last few years and making some prophecies in regard to our future position in the shipping world, the following statement was made:

"The point we have sought to bring out is that America has now so developed her iron and steel industries that she must find fresh outlets for her products. Such outlets she is finding, as we believe, with profit in foreign markets, for certain products. For other products, however, she will need to create a new shipbuilding industry of her own, and what has been done, or is being done in that direction, we must reserve for future examination. No thoughtful man, acquainted with the American character, who considers the situation, can fail to perceive that the greatest competition to be faced by British industry and enterprise in the future is that of American shipbuilding. It may be deferred a few years, but it is bound to come."—*Scientific American Supplement.*

BRITISH SHIPBUILDING.

From an address before the Institution of Naval Architects.

This has been a year that will never be forgotten in the annals of the mercantile marine of Great Britain. Her Majesty's government, on the outbreak of the war in South Africa, found themselves compelled to rely solely upon the merchant steamers of the country, in order to transport to the scene of operations the largest military force that has ever been sent across the seas by any state in the world's history. It is satisfactory to learn, on the authority of the First Lord of the Admiralty, that the work has been admirably performed. As far back as February 17, 181 transports and freight ships had already been employed to carry over 132,000 officers and men, together with 50,000 horses and mules, and the stores and material for this large force. These figures are exclusive of the troops, horses, etc., conveyed from India and the colonies. Though the distance traversed was 6000 miles, not a single life has been lost during the operation, and the few mishaps that have befallen the steamers have been due to the risks of navigation. Since the date of the First Lord's speech, the figures mentioned above have been very considerably increased; but, nevertheless, the immunity from accident continues. The fact that it has been found possible to confide with perfect security, the safety of its principal fighting force to the ships of private owners entitles me to congratulate them, as well as the builders and the registration societies which framed the rules under which most of the vessels and engines were constructed, upon having created a mercantile fleet of such efficiency that the state was enabled to make full use of it in its hour of need. We have always been accustomed to reckon the mercantile marine as one of the greatest of our commercial assets, but I doubt if the people of this country have hitherto been aware that they also possessed in it a military factor of the first importance. It is, therefore, on national, as well as on commercial grounds, that I am able to congratulate our shipbuilders upon the fact that, in the year 1899 they have again broken all records with an output of mercantile shipping amounting to 1,416,791 tons, a figure which exceeds the total of the previous year by 49,000. In addition, warships having a total displacement of 168,590 tons were launched in British yards, of which about two-thirds were built in private establishments. The orders now in hand, it is true, show a slight diminution when compared with the figures of the corresponding period last year. The latest returns prove that 1,306,751 tons are now under construction, as against 1,400,000 tons a year ago; but this falling off will hardly occasion surprise when we consider how intensely active the shipbuilding industry has been since the termination of the great labor dispute in 1897. The returns bear witness to the continually increasing size of merchant steamers, for no less than sixteen vessels of 10,000 tons and upwards were being built, of which eight were launched during the year, exclusive of the Oceanic, to which I referred in my last annual address. Of these, the largest was the Ivernia, of 13,900 tons, which we had the advantage of inspecting, thanks to the kindness of C. S. Swan and Hunter, on the occasion of our visit to Newcastle-upon-Tyne.

The sale of British vessels to foreign owners appears to be going on at an increasing rate. During the last year no less than 609,589 tons were transferred to foreign flags, this being the largest figure on record. Nevertheless, the net additions to the British register were considerable, having amounted to 399,865 tons. The number of ships on the register, however, shows a diminution of 195, in consequence of large removals of sailing vessels from the lists.

Our foreign friends, who are such active supporters of this Institution, have, I am glad to say, fully shared in the prosperity of the shipbuilding industry. In France 90,000 tons of mercantile vessels and warships, of 65,000 tons displacement, were launched. The construction of sailing ships, almost abandoned elsewhere, continues to flourish under the French bounty laws. The returns include two such vessels, the Ville de Mulhouse and the Ville de Havre, each of 3214 tons.

The returns for the United States, Germany, and Italy all show considerable increases over even the noteworthy figures of the previous year. About one-third of the tonnage launched in the States was for service on the Great Lakes. It may give an idea of the importance of the waterborne commerce of these inland seas if I mention that eleven steamers of upwards of 4000 tons, and two sailing barges of over 5000 tons each were launched last year for the lake trade.

The Germans have again distinguished themselves by the construction of several steamers of very large size. These include the Patricia, of 13,292 tons; the Grosser Kurfürst, of 12,500 tons; and shortly after the close of the year they launched the Deutschland, of about 15,500 tons, which, next to the Oceanic, is now the largest vessel afloat.

Turning to the Royal navy, the new shipbuilding programme appears at first sight to be a somewhat modest one. In the coming financial year it is proposed to lay down two battleships, six first-class armored cruisers, one second-class cruiser, and six small vessels. It must not, however, be forgotten that we have already under construction a large number of armored and unarmored vessels. In the course of the coming year there will be building or completing the following ships: Seventeen battleships, twenty armored cruisers, one first-class protected cruiser, one third-class cruiser, and thirty-six other vessels of various classes; a very tolerable-sized fleet in themselves. I cannot, however, refrain from expressing the regret which I share with the naval authorities that, owing to a variety of circumstances, such as the non-delivery of material, the rapidity of construction, of which we have in the past been so justly proud, has not during the last two or three years been fully maintained. So far as I have been informed, the chief causes of delay have been owing to restricted output of the best class of propelling machinery and of armor-plate. The situation has been described by the First Lord of the Admiralty as one of some difficulty. In my opinion it might resolve itself into one of some gravity, or even danger. I cannot myself believe that we have reached the limit of our producing power in these two directions, or that we are straining our unrivalled resources. The difficulty of procuring armor-plate seems to be the more acute of these two questions. I venture, with the utmost respect, to suggest that two courses are open to the government. Either to extend by means of orders guaranteed over a series of years, the number of firms capable of supplying armor-plate; or for the state itself to undertake its manufacture. I am aware that this latter course is open to serious objections, which I need not particularize, but I am confident that the people of this country are so fully alive to the absolute necessity of possessing an all-powerful fleet that they will not consent, year after year, to see money which they cheerfully grant for constructive purposes, either allowed to lapse, or else devoted to purposes other than those which their representatives intended it for.

It must be satisfactory to all those who closely study the conditions of efficiency and mobility of a fleet to learn that the Admiralty are giving their earnest attention to the question of fleet auxiliaries. While it is highly desirable that every warship should be, to the greatest possible extent, self-contained, no modern squadron can be considered independent unless accompanied by specially fitted colliers, repairing-ships, magazine-ships, hospital-ships, and distilling-ships. Looking to the extreme rapidity with which modern naval warfare is likely to develop, it is to be hoped that too great reliance will not be placed upon vessels improvised at the last moment to fulfil these purposes.

Another question, which might become a burning one, is the restriction upon the employment of wood in all fighting ships. Many foreign nations are, I believe, entirely abandoning the use of wooden decks and wood fittings in their military marines. If we are not following their example as closely as some might wish, it is because our ships have to keep the sea for longer periods than do those of our neighbors, and we are bound, therefore, to give greater consideration to their habitability; but, while we do not lose sight of this important factor in the health and efficiency of our ships' companies, it is earnestly to be hoped that all inflammable material will be cut down to the narrowest possible limits, and be made easily removable when clearing ships for action.—*The Engineer.*

THE IMPERIAL JAPANESE NAVY.*

By Rear-Admiral C. C. P. FitzGerald, Associate.

The first real start made by Japan in the production of a modern navy seems to have been the purchase of the ironclad Stonewall Jackson from the United States government in 1866. She was a small ship of only 1300 tons burden, but she carried a 10-ton gun, besides some smaller ones, and was a powerful ship of her day; she was re-named the Adzuma. The first ship built in England for the Japanese government was the Foo-So. She was built at Poplar by Samuda, from designs by Sir Edward Reed, and was launched in April, 1877. She was a broadside central-battery ship, bark rigged, 220 feet long, 48 feet beam, 3718 tons, double screw, speed 13 knots, engines by Penn. This ship was followed by the Kon-go, Hi-yei, and Rin-jo, all small ironclads not exceeding 2300 tons, but carrying powerful armaments for their size. There were also about half a dozen unarmored ships of little fighting value. This was the state of the Japanese navy in 1880. Five years later—1885—Japan had only added one small ironclad to this list; but there were "built and building" for her several fast and powerful cruisers, armed with Krupp and Armstrong guns. The ironclads, with the exception of the Foo-So, were built of wood. Five years later—1890—she had again only added one ironclad to her list, in the shape of an armored gunboat; but she had by this time provided herself with a considerable squadron of fast and well-armed cruisers, built in various foreign countries. By 1895, although she had not actually added to her list of armored ships, there were building for her in England two battleships of the most powerful type, exceeding 12,000 tons displacement, and with a proposed speed of 18 knots; she had also added considerably to her list of fast cruisers. One of these, the Yoshino, built at Elswick, had a measured-mile speed of 22.5 knots.

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* Institution of Naval Architects, April, 1900.

There can be no doubt that the Chino-Japanese war gave an immense impetus to the development of the Japanese navy; not only were ships captured from the Chinese, some of which were repaired and are now in commission, but large orders were placed abroad for warships of all classes, including torpedo craft, and the Japanese also set to work to build ships in their own dockyards. The Japanese navy now stands as follows, eliminating ships which appear to be of insignificant fighting value, but including those which are expected to be ready during the current year:

Battleships.

Fuji	Thames Iron Works.
Yashima	Elswick.
Shikishima	Thames Iron Works.
Asahi	John Brown and Co.
Hatsusi	Elswick
Mikása	Vickers and Co.

These are first-class battleships in the fullest sense of the term, ranging in tonnage from the 12,300 of the Yashima to the 15,000 of the Asahi, Hatsusi, and Mikása. Their speeds are all at least 18 knots, and they are armed with the most powerful modern guns, and considerable areas of their sides are protected by the latest and most up-to-date face-hardened armor. Four of the six carry more armor and more guns than British first-class battleships, but less coal. There is also the Chinyen—late Chin Yuen—captured from the Chinese, German built. I have seen her quite lately. She has been thoroughly repaired, and is now in commission, and although she cannot be classed as a first-class battleship, being of only 7220 tons, and 14 knots speed, she is a powerful ship of her class. There are also three small ironclads—Fuso, Hi-yei, and Kon-go—built in England in the seventies, before alluded to, and the Hei Yen, captured from the Chinese; they are of very small fighting value, and three of them are used as training-ships.

Armored cruisers.—Although Japan won the battle of Yalu with second-class cruisers fighting against armored ships, her statesmen are not under the delusion that second-class cruisers will be sufficient to meet the growing needs of their rapidly expanding empire, and they are, therefore, adding to the fleet six very powerful armored cruisers of about 9800 tons displacement and about 20 knots speed:

	Tons.	Speed.	Armament.
Tokiwa Asama Idzuma Iwate	9750	21.5	Four 8-in., fourteen 6-in., and twelve 12-prs.

These are all Elswick ships, designed by Mr. Philip Watts. The Tokiwa and Asama are completed, the Idzuma will be delivered about the middle of this year, the Iwate towards the close of it. The Idzuma, of 9436 tons, but the same armament, and 20 knots speed, is building at St. Nazaire, by the Société de la Loire, and is to be ready this year. The Yakuma, of 9850 tons, and the same speed and armament as the Idzuma, is building at the Vulcan Works, Stettin, and I am informed she is to be ready this year. The above ships constitute a squadron of six extremely powerful vessels, call them what you will, battleships or cruisers; at any rate not a few of the so-called "naval experts" think such ships are fit to "lie in the line" and take their place amongst battleships. They are at least as powerful vessels as some that are classed as second-class battleships in our own and some foreign navies, and they have a great advantage in speed. Japan owns another armored cruiser, the Chiyoda, built in Glasgow in 1890, with a nominal speed of 19 knots; she is a small ship of only 2450 tons, and she cannot be assigned a very high fighting value in the present day, though she took part in the battle of Yalu.

Unarmored Cruisers, Second-Class.

	Tons.	Speed.	Armament.
Chitose	4760	22.5	Two 8-in., ten 4.7-in., and smaller guns.
Kasagi	4784		
Takasago	4160		

The Chitose was built at San Francisco, the Kasagi at Philadelphia, and the Takasago at Elswick.

*Yoshino	4150	22.5	Four 6-in., eight 5-in., and smaller guns.

This ship was built at Elswick.

*Akitsushima	3100	19.0	Four 6-in., six 5-in., and smaller guns.

This ship was built in Japan.

*Naniwa	3650	18.7	Two 10-in., six 6-in., and smaller guns.
*Takachiho			

Built at Elswick in 1885.

We come now to a group of a peculiar type of cruiser, carrying one very heavy gun forward, and a battery of light guns on the main deck aft.

	Tons.	Speed.	Armament.
*Matsushima	4210	16.0	One 12-in., eleven 5-in., and smaller guns.
*Itsukushima			
*Hashidate			

NOTE.—The ships marked * took part in the battle of Yalu.

The two former ships were built in France in 1889; the latter in Japan two years later. Such an armament appears to be out of place in a cruiser, and a nominal speed of 16 knots to be inadequate. It does not appear that this type is likely to be repeated.

Third-class cruisers and small craft.—Japan possesses several third-class cruisers of good speed, capable of acting as scouts. She has also a considerable number of small vessels of low speed and but little fighting value, which it would be waste of time to describe. But there are six gunboats of the Chinto class, captured from the Chinese, carrying one 11-inch gun. These might be useful as coast-defenders.

Torpedo flotilla.—The peculiar nature of the Japanese coast-line, with its numerous harbors, and the Inland Sea with its archipelago of islands, are physical features in Japan which offer special advantages for the use of torpedo-boats; and she is, therefore, providing herself with a powerful torpedo flotilla of the most modern type of vessels. Messrs. Yarrow, Thornycroft, Normand, and Schichau are all building either torpedo-boats or destroyers for the Japanese government, and some are also being built in Japan. A torpedo transport on the plan of our own Vulcan and the French Foudre is projected, but my information does not enable me to state whether the order has actually been placed or not. Yarrow and Co. have just completed six destroyers of 31 knots' speed and upwards, and the same firm has now in course of construction ten first-class torpedo-boats for the Japanese government. Thornycroft and Co. have also just completed six destroyers of about 50 tons less displacement than the Yarrow boats, and with speeds of 30 knots and over. Japan already has in commission and in reserve, a considerable number of first and second-class torpedo-boats, some of these being constantly used for exercise. It is interesting to note that an armor-plated torpedo-boat named the Katoka, 166 feet long, with 9 feet 6 inches beam, built for the Japanese government by Yarrow and Co., in 1885, led the torpedo attack both at Port Arthur and Wei-hai-wei. It seems that the Japanese not only know how to order a good article, but to use it when they get it.

Dockyards.—There are three Imperial dockyards in Japan—Yokosuko, Kuré, and Sassebo. They are all capable of being effectually defended. A fourth, Maisuru, on the northwest coast of the main island, is also in course of construction. Sassebo can only be approached through narrow and tortuous channels, and from its natural position, may be considered absolutely unattackable from the sea. Kuré is in the Inland Sea, and its position also is naturally a very strong one; the islands around it are being strongly fortified, and it will shortly be impregnable to sea attack. It is, moreover, to be remarked that with the powerful torpedo flotilla Japan has already got, and is still further increasing, hostile ships operating in the Inland Sea would be likely to have a bad time. Yokosuko is in the gulf of Yeddo, and very favorably placed for defense. The heights around are already fortified, and the works now in progress at the entrance to the gulf will protect not only Yokosuko, but also Tokyo and Yokohama, and forbid this large stretch of enclosed water to any hostile squadron. Nagasaki, where there is a private shipbuilding yard that turns out large merchant steamers, and where there is one first and one second-class dock, is being strongly fortified; and from its position it is a place of strategic importance. At Hakodati, in the North Island of Japan, the harbor is being artificially improved, and, although there is no dockyard here, the port is being fortified as a harbor of refuge. This place bears a striking resemblance to Gibraltar. At Oterrani, also in the North Island, extensive harbor works are in progress, an interesting description of which was lately given in *Engineering*.

Up to the present the Japanese dockyards have not undertaken to build a battleship, and the largest cruiser they have built is the Hashidaté, of 4200 tons and 16 knots speed; but they hope soon to be able to build first-class cruisers at Yokosuko, and eventually battleships. At this dockyard there is a first-class modern dock, in which one of the heaviest battleships of the British navy—the Victorious—was lately docked for cleaning purposes, and I never saw a similar operation more quickly, more quietly, nor more methodically performed in any English dockyard. In the *Jiji Shimpo* (*Times* of Japan), of February, 1899, Mr. S. Sassow, Chief Director of Naval Construction, writes as follows concerning Yokosuko dockyard: "This dockyard was established during the Tokugawa regency by the Shogunate in 1866. French officers, comprising naval constructors and engineers—Mons. Verner being the chief director—were engaged, together with a considerable number of leading workmen, for originating the work and for instructing Japanese workmen; several wooden ships have been built here. In 1875 the services of the greater part of the French employees were dispensed with, and the administration passed entirely into our own hands. . . . We are now building entirely of steel. Our artisans in all branches of shipbuilding and engineering have now attained to a considerable skill. . . . Hitherto the limit of size at Yokosuko has been 5000 tons; but it is intended to enlarge the dockyard so as to be able to build cruisers of all classes; and in course of time we expect to be able to build battleships. All materials have to be purchased abroad, even for building cruisers."

With regard to steel armor-plate manufacture, Mr. Sassow says: "Should such be established in Japan, it would hardly be able to manufacture plates within six years from starting. With the experience of six years even they will probably find that it will be only after many years of further experience they are able to turn out plates of uniform thickness." Under these circumstances, the armor-plate manufacturers of Great Britain need not feel any immediate alarm of dangerous competition from Japan.—*The Engineer*.

THE UNITED STATES CRUISERS OF THE DENVER CLASS.

The Denver is one of a class of six that were provided for in the Naval Appropriation Bill for the fiscal year ending June 30 next. The vessels were first known as protected cruisers 14 to 19, but have since been named the Denver, Des Moines, Chattanooga, Galveston, Tacoma, and Cleveland.

The vessels are, of course, to be twin-screw, the propelling engines being right and left-handed; they are of the inverted, direct-acting, four-crank, triple-expansion type. There is one piston-valve for the high-pressure cylinder, and two for each intermediate-pressure cylinder, and one flat slide valve for each low-pressure cylinder.

Diameter of high-pressure cylinder	18	in.
" intermediate-pressure cylinder	29	"
" low-pressure cylinders	35¼	"
Stroke	30	"
Revolutions at full power per minute	172	
Steam pressure in boilers	275	lb.
" " at engine	250	"
Diameter of crankshaft	9¼	in.
" crankpin	9¼	"
Length of crankpin	11	"
Diameter of axial hole in shaft	5	"
" piston valves	11	"

The sequence of cranks in turning centers is in order as follows: High-pressure, intermediate-pressure, forward low-pressure, and after low-pressure. The order of the cylinders is forward low-pressure, high-pressure, intermediate-pressure, and after low-pressure. The collective indicated horse-power of the propelling and circulating pump engines was originally designed to be 4500, with the main engine making about 172 revolutions per minute at the steam-pressure named; viz., 250 pounds at the engine. The engine bedplate is of cast-steel. The crankshaft for each engine is forged in two pieces, the shaft for the forward low-pressure, and the high-pressure cylinder, forms one piece, whilst that for the intermediate-pressure cylinder and the after low-pressure cylinder are formed of another piece. All crank, thrust and propeller shafts are hollow. The shafts, piston-rods, connecting-rods, valve-rods, eccentric-rods, and working parts generally are of forged nickel-steel. There is in the design a single-acting air-pump worked from the crosshead of the forward low-pressure cylinder.

There will be one separate cylindrical main condenser to each set of engines, placed in the wings of the engine-room, as usual with an arrangement of machinery of this nature. The total cooling surface of each, as designed, is about 3000 feet, or 6000 feet in all. Each main condenser will have one centrifugal circulating pump. There will be two auxiliary condensers, each with a cooling surface of about 450 feet, and these condensers will have combined air and circulating pumps. The auxiliary condensers are of the cylindrical type and are placed athwartships against the after engine-room bulkhead. The propellers are of bronze and are right and left-handed, turning from the ship.

According to the original design, it was specified that the boilers should be six in number and of the water-tube type, giving steam for an aggregate of 4700 indicated horse-power. The total grate surface was at least to be 300 square feet, and the total heating surface about 13,200 square feet. The boilers were to be in two compartments with fire-rooms athwartships, and there were to be two smoke-pipes for all the six boilers. "The forced-draft system," it is stated in the proposals, "will consist of three boilers discharging into airtight fire-rooms. The air for combustion will be heated by the hot gases circulating among or through tubes arranged in the uptakes or in the upper part of the boiler casing, and will be conveyed through ducts fitted with dampers to closed ashpits." In addition, the following engines are to be supplied and worked by steam, viz.: Steering engine, capstan engine, four deck winches, two ash hoists from each fire-room, dense air machine with capacity of 1 ton of ice per day, engine for machine tools, and evaporating and distilling plant in two units, each having a capacity of 4000 gallons per day. The following auxiliary machinery is to be electrically operated: Blowers for hull ventilation, and two winches for hoisting ammunition.

The main elements, according to the latest advices, may be here added:

Length on water line	292 ft.
Beam at " "	44 "
Trial displacement	3200 tons
Greatest draft, full load	16 ft. 11 in.
Total bunker capacity, not less than	700 tons
Coal on trial	470 "
Feed-water, trial.	40 "
Speed on trial, at least	16½ knots
Full load displacement	3500 tons

The above particulars are taken from the *Journal of the American Society of Naval Engineers*. We are also indebted to the same valuable publication for the following interesting details of weights which are taken from the United States Naval Department's design:

	Tons.
Guns, mounts, shields, &c., about	98
Ammunition, ordnance, stores, and outfit, about	155
Machinery complete, about	405
Engineers' stores, about	22
Fresh water for steaming purposes	40
Total coal	700
Boats and outfits	13
Masts and spars	14
Electric plant and electric outfit	29
Equipment, including anchors, chains, rigging, &c.	72
Officers, crew, and outfit	37
Miscellaneous and provisions, and clothing stores	92

As previously stated, the tenders, or bids, for these six cruisers have been lately received, and it will be interesting to consider them in connection with the proposals put forward by the United States government, more especially as the procedure followed in America differs somewhat from our own. The Naval Appropriation Bill providing for these ships was that which dealt with the provision of vessels for the United States navy up to the end of the present fiscal year, which terminates on June 30 next. There were authorized to be constructed by contract, three seagoing coast-line battleships, three armored cruisers, and these six protected cruisers. The general particulars of the ships were laid down in the bill, and they are each to cost, exclusive of armament, not more than $1,140,800. The Secretary of the Navy was directed to award the contract to the "lowest responsible bidder, having in view the best results and the most expeditious delivery." Not more than two of the seagoing battleships, and not more than two of the protected cruisers, were to be built in one yard or by one contracting party. It was further provided "that one and not more than one of the seagoing battleships, and one and not more than one of the armored cruisers shall be built on or near the coast of the Pacific Ocean." The President was, however, allowed to exercise his discretion in regard to the latter provision if it was found that the vessels could not be built on the Pacific side at a cost not exceeding 4 per cent. above the lowest accepted bid for the other ships.

There is a good deal that is interesting in the provisions of this bill, especially when considered in conjunction with the armor-plate questions in which the United States Congress has recently thought fit to interfere with not very fortunate results. No doubt a wise discretion is exercised in fostering shipbuilding enterprise on both ocean coast-lines of the country, as thereby the naval strength of the nation is increased, although a cynically inclined American citizen might be apt to attribute the procedure to the influence of Pacific coast votes. But in any case it would be more satisfactory, we should think, to have these matters left to the Secretary of the United States Navy and his professional advisers; as, in this country, they would be left to the First Lord of the Admiralty. Unfortunately these wider questions of national policy are the kind of things our First Lords never seem to consider; because, it may be presumed, they are subordinate to the Treasury—which never recognizes anything more imperial than the lowest tender—and also because they are afraid of questions in the House. The "awards" for the six cruisers were made on November 27 last, as follows: Galveston, Wm. R. Trigg & Co., 24 months, $1,027,000; Chattanooga, Lewis Nixon, 30 months, $1,039,966; Cleveland, Bath Iron Works, 30 months, $1,041,650; Tacoma, Union Iron Works, 27 months, $1,041,900; Des Moines, Fore River Engineering Company, 30 months, $1,065,000; Denver, Neafie & Levy, S. and E. B. Company, 30 months, $1,080,000.

These contracts are for the department's designs with a speed of 16½ knots. There was offered by one firm a lower price than any of those named, namely, $954,500, but their tender was not accepted. There were also three bids somewhat higher. The closeness of some of the tenders is quite a coincidence, and indicates how very well the estimating department is managed in some of the works.

Contractors were invited to submit tenders on modified designs at higher speeds, but the American Board of Construction decided to recommend acceptance only of the department plans. It will, however, be interesting to give some of the tenders made by contractors on their own plans. The firm who gave the lowest price, not accepted, for the department design, made a bid of $1,059,500 for a 17½-knot ship, or only $105,000 for the extra knot. For an 18-knot ship with Thornycroft boilers, Messrs. W. R. Trigg & Co. bid $1,041,000, or only $14,000 for the extra speed, say 2800*l.* for a knot and a half. That appears surprisingly cheap, but the Fore River Engine Company were even more liberal, and offered the knot and a half for nothing, being willing to take $1,065,000, whether the vessel steamed 16½ or 18 knots. It must be remembered, however, that the latter speed was to be obtained on their own designs, a circumstance that makes a good deal of difference when dealing with governments. For an 18½-knot ship the Fore River Company asked $1,100,000; and for a 19-knot ship with Thornycroft boilers, Messrs. W. R. Trigg & Co. asked $1,079,000, or only $52,000 over their 16½-knot price. Most of the firms offered lower prices if awarded two ships.

It would seem from these figures—for we may presume that the contractors did not offer unserviceable or absurd designs—that the United States authorities do not set an inordinately high value on speed; as our own naval authorities have been accused of doing. Admiral Hichborn, who corresponds to our Sir William White, being head of the United States Construction Department, has expressed his disapprobation of "show vessels" and "fancy results." Probably his department look on excessive speed as one of the "fancy" or "showy" attributes. The value to be attached to such qualities, however, is a matter for seagoing naval officers, who will fight the ships, to decide. It is easy to understand how a naval constructor may go in a direction quite contrary to that of Admiral Hichborn, and be carried a little too far in his estimate of the value of speed, for in times of peace it is often the only quality—putting aside, of course, price—by which the general public judge of the success of a warship. Nevertheless, experience has shown that speed has a high fighting value in steamship actions.

What boilers are actually to be put in the different ships by various builders we are not aware. They are, however, to be of the water-tube type.—*Engineering.*

THE HAMBURG-AMERICAN ATLANTIC LINER DEUTSCHLAND.

This vessel has been built by the Stettiner Maschinenbau Actien-Gesellschaft Vulcan, at Bredow, near Stettin, where also the North German Lloyd steamer Kaiser Wilhelm der Grosse was constructed and engined. The latter has attained a speed on the Atlantic of 22½ knots, and has thus excelled all previous performances; and the new ship is expected to make 23 knots in service, and is equipped with engines to develop 33,000 indicated horse-power, the greatest power fitted in any ship up to the present time. The fastest of our British Atlantic liners are the Campania and Lucania, and they have a displacement tonnage of about 17,000 tons, their length between perpendiculars being 600 feet; the Kaiser Wilhelm der Grosse is 625 feet long and of 19,800 tons displacement; and the Deutschland 662 feet 9 inches long and 23,000 tons displacement. The British ship may be put at quite 22-knot speed, and it is interesting to note that the power has not increased at the ratio one would expect in view of displacement and speed, a fact due probably to the greater length of the hull. The Deutschland is to leave on the first voyage to New York on June 17, and her performance will be watched with interest. In this connection it may be noted that she is to leave Hamburg every three weeks instead of every fourth week, as has been the case with the Atlantic liners hitherto. This practice has also been adopted by the

American line, and secures the advantage of a greater amount of work from the ship within a given time, experience having shown that those high-speed liners are, as a rule, superseded by faster boats before they have done a full share of work.

The Deutschland is 662 feet 9 inches long between perpendiculars and 686 feet over all, 38 feet longer than the Kaiser William der Grosse. Her beam is 67 feet, 1 foot more, and moulded depth 44 feet, also 1 foot greater. The gross tonnage is 16,000, and the displacement 23,000 tons.

The machinery differs from the Kaiser Wilhelm der Grosse, which has four-cylinder, triple-expansion engines; the Deutschland has six-cylinder, quadruple-expansion engines, and thus, notwithstanding the increase of power and quadrupling, the low-pressure cylinders are only 106.3 inches, not by any means a maximum, as compared with 96.4 inches. The two low-pressure cylinders are in the center, with the two high-pressure cylinders over them, and at the forward end is the first intermediate and at the after end the second intermediate. The two first cranks, set opposite each other, have thus the intermediate in the one case, and a high-pressure and low-pressure cylinder in the other, and the after pair of cranks, a high pressure and a low pressure in the one case, and the intermediate on the other crank. The cylinders are placed close together, the valves being on the outside, and there is a separate valve gear for each cylinder, *i. e.*, six sets for the six cylinders of each engine. The end cylinders have their valve boxes on the outside, and owing to the great diameter there are two spindles, a system adopted in the Kaiser Wilhelm der Grosse. The diameters of the cylinders are as follow:

Two high-pressure cylinders	30.6 in.
One intermediate-pressure cylinder (I.)	73.6 "
One intermediate-pressure cylinder (II.)	103.9 "
Two low-pressure cylinders	106.3 "
Common stroke	72.8 "

Together the engines are to indicate 33,000 horse-power, when running at about 76 revolutions per minute. The cooling surface of the two surface condensers total 42,630 square feet.

There are twelve double-ended and four single-ended boilers, divided equally into four sets for four boiler compartments.—*Engineering.*

SUBMARINE BOATS.

Interest has again been revived in the subject of submarine boats, owing to the report that France has decided upon the construction of a large fleet, 100 being given as the number, while the United States navy authorities have come at last to the conclusion to purchase the Holland boat after many trials. This uncertainty of opinion is shared by all governments, excepting only that of France, in which country the conditions of a naval war are such as to justify the undertaking of the risks more or less inseparable from the submersibility of such craft.

Although it would not be quite accurate to say that there has not been advancement towards the solution of the inherent difficulties to submarine navigation, a glance at the successive experiments is not by any means encouraging.

The first submarine boat did not drown anybody; but whether or not the great Cornelis van Drebbel actually submerged the boat which he exhibited before James I. on the Thames in 1624, is not quite clear. Day did go down at Yarmouth in 1660, and when he repeated his experiment, boat and crew failed to reappear. Fulton was more successful: he kept four hours under water in 1801, and exploded a mine at Brest from his boat. Phillips' wooden boat was crushed by the water pressure on Lake Erie, and the same fate befell Bauer's iron boat in 1850 at Kiel; he and his two men had a marvellous escape, being carried by the huge compressed air-bubble. The boat of McClintock and Howgate, constructed in 1863 for the Confederates in the American civil war, sank four times, and each time killed its volunteer crew, 32 men in all. All these craft had less than 30 tons displacement, employed water ballast and manual propelling power, and resembled plumply-built fish in their shape.

With the same year, 1863, began the days of the cigar-shaped boats of considerably larger tonnage, fitted with steam, pneumatic, petroleum, or electric power, and sometimes with two separate sets of motors, for motion on the surface and under water. Noteworthy among these are Nordenfelt's four boats, which burned fuel when on the surface, and relied on the heat stored in the boiler when under water. During the last fifteen years another type has come to the front: boats which keep just under the water-line, and which are to dive under only in extreme cases. To this class belong the boats of Hovgaard, of Peral, and the several craft which Admiral Aube had constructed: the two boats of Goubet, Zédé's Gymnote, and the Gustave Zédé. France has been most persevering in these endeavors. Last summer, Romazotti's Morse was launched at Cherbourg; she is to have two sisters, the Français, and the Algérien; and there is finally Laubert's Narval, also launched at Cherbourg in October last, fitted with petroleum and electric motors and accumulators, whilst the other French boats mentioned depend entirely upon accumulators. Giorli's boat of 1893 is distinguished by three horizontal rudders, one of which is automatically adjusted by a pendulum. Finally, there are the six Holland boats, the last of which is entirely of Mr. Holland's own design.

The flooded boats, which keep awash, just under the water surface, look like torpedo-boats. They are spacious enough not to need any compressed air stores for breathing; and the tube projecting above the water-level, provided with a mirror at an angle of 45 deg., is a help to the man at the helm—not much of a help, though, for the elevation is too small to give a proper field of view. In stability these craft are superior to the totally submerged boats, but they suffer from many of the drawbacks of submarine boats which are regarded as serious, notably by such an expert as Professor Busley. He is acting president of the newly formed Schiffbautechnische Gesellschaft, a German naval constructors' institution whose inauguration recently was attended with so much *éclat*, due to the presence of the German Emperor to hear the professor's contribution on this important subject of submarine boats.

Amongst those serious inherent difficulties, Professor Busley places first the low stability of submarine boats. Some people still seem to forget that the displacement center of gravity of a totally submerged boat is simply the mass center of the water displaced, and does not alter its position whatever inclination the boat may assume. There is no buoyancy. Yet transverse stability and prevention of rolling, are not so difficult to obtain, provided the section of the boat is like that of an egg, poised on its point. If we use ballast, the center of gravity of the system will be low down, and the displacement center high up. The low longitudinal stability, the tendency to pitching, is the trouble. A man need only step forward to send the nose of the boat down. For this reason the Plongeur of Bourgeois failed, and the length of boats has been reduced again. Goubet has gone furthest in this direction, and his two men always sit in the middle of the boat. Bauer tried to apply counterpoises, Holland automatic pumps, to restore longitudinal equilibrium. Nordenfelt did not deprive his boat of all buoyancy and counteracted its effect by a submerging propeller. The flooded boats are better off in this respect. But even in their case we notice a reduction in length; the Zédé had a length of 45 meters, the Morse of 36 meters, the Narval of 34 meters. It has, on the other hand, been pointed out that they are not good seagoing boats, hardly fit for rough weather; and their own designers have proposed to give them a little freeboard. If we do that, we lose the chief advantage of the submarine boat, the immunity against projectiles; and we may argue whether we had not better return to ordinary boats, in which we are not tied down to small space and small speed, and all sorts of undesirable conditions.

Submarine boats remain dangerous to manage. On the average, perhaps, we may construct them strong enough to descend to a depth of 100 feet. Supposing a boat, moving at the usual speed under water, 8 knots, is to discharge a torpedo. Two men are sent forward; the boat at once inclines 15 deg., and within half a minute it will have arrived in its critical depth. If there is any delay or any fault in the steering gear or in the application of safety weights, etc., every second will seriously increase the pressure of the water outside. Trials made with the Gymnote, moreover, indicate that submarine boats do not obey their horizontal helms with sufficient rapidity. The Gymnote always overshot her mark, and would not keep on a straight course, but described a succession of curves. Professor Busley tried to pull a submarine boat under water; it could not be done when the speed exceeded 4 knots. That all operations near the coast or in shallow water are exceedingly dangerous, need not be emphasized. Campbell's boat managed to wriggle herself out of the Thames mud again in 1886; the accident testified to the nerve and skill of Lord Charles Beresford, and also to his good luck.

These dangers are increased by the exceedingly limited range of sight under water. Light emanating from a focus under water will, at a distance of 100 yards, not have the ten-millionth part of its intensity; and not much of the daylight penetrates into the water as it is. On a clear day, a diver 20 feet below the surface, is hardly able to see further than 25 feet. Searchlights would be of little good, and would, moreover, betray the position of the craft. Hence the boat must approach the ship it wishes to attack very closely; and if the ship is moving, the case is almost hopeless. So far, we hardly know of submarine boats doing more than 8 knots. The slow speed is largely due to the weight of the batteries, which for a journey of five or six hours would weigh about 6 cwt. per indicated horse-power; and we appear as far as ever removed from materially diminishing the weight of electric accumulators.

This low speed, and the short period during which such a boat can be kept in motion without replenishing its charge, limit the range of action of the submarine boats badly. The Gymnote could make a run of 45 miles at 10 knots, it has been said; most submarine boats have not accomplished so much as that. The submarine boat thus can merely be utilized for the defense of a port, and it is a very expensive means of defense. The Narval is stated to have cost about 30,000*l*. Adding a third to this sum, we could construct a torpedo-boat destroyer of four-fold speed and three-fold displacement which may achieve something. Whether a submarine boat would ever escape from a successful attack is a very doubtful question. Professor Busley does not dwell upon that point. But if the boat almost has to feel its way up to the object of attack, because it cannot see to any distance, the chances of escape are decidedly poor.—*Engineering.*

AMERICAN FREIGHT LOCOMOTIVES AND THE ENGINES OF THE OCEANIC—A COMPARISON OF HORSE-POWER.

We are told that "comparisons are odious," and the statement would seem to be based upon a fairly correct estimate of human nature; but as soon as we get outside of the range of human susceptibilities and apply our comparisons to insensate things, comparisons become not only extremely interesting, but at times a valuable means of increasing our general knowledge and our sense of the proper relative proportion of things.

In addition to the usual information as to dimensions and construction, Mr. R. Wells, the superintendent of the Rogers Locomotive Works, has favored us with particulars of some novel experiments which he carried out to determine the exact location of the center of gravity of this locomotive above the rails. He has also given us particulars of its horse-power and freight-hauling capacity on a level road, and it occurs to us that a comparison of the relative power of one of these engines when working up to its maximum indicated horse-power with the maximum indicated horse-power of the Oceanic, the largest steamship in the world, will be attractive to that section of our readers that likes to have its facts enlivened occasionally with a touch of the fanciful and curious.

The locomotive was designed to haul trains of a maximum weight of 2000 tons over grades of 38 feet to the mile. The cylinders are 23 inches in diameter, by 30 inches stroke; the drivers are 57 inches in diameter and they carry 198,000 pounds weight of the locomotive out of a total weight of 218,000 pounds. The boiler, which is of the Belpaire type, is 80 inches in diameter at the smoke-box; the fire-box measures 42 inches by 132 inches, and there are 417 2-inch tubes which are 13 feet 8 inches in length. There are 252 square feet of heating surface in the fire-box, and 2951 square feet in the tubes, making a total heating surface of 3203 square feet. The tender is exceptionally large, the capacity of the tank being 5000 gallons, while the coal space has a capacity of 10 tons.

The increase in the diameter of locomotive boilers which has taken place of late years has necessitated their being carried above the tops of the wheels, with the result that the center of the boiler is in some recent locomotives as much as 9 feet above the rails. To the uninitiated these immense machines have an exceedingly top-heavy appearance, and it looks as though their stability would be endangered, especially when they are running at high speed around a curve. Before sending this engine out of the shops, the Rogers Locomotive Company made an experimental test to determine the exact location of its center of gravity. The result is certainly surprising, for although the top of the boiler is fully 9 feet above the rails, the center of gravity was found to be only 50½ inches above the top of the rails, that is to say, about 6½ inches below the top of the driving wheels. As a matter of fact, the great bulk of the boiler is very deceptive to the eye, and one is liable to forget that the greatest concentration of weight lies in the heavy frame, the wheels, the axles, cranks and running gear, and the heavy saddle and cylinder castings. The test was made by suspending the engine on the upper surface of two 3-inch steel pins or journals as pivots, the one at the front being located 6 inches in front of the cylinder saddle, and the one at the rear, 6 inches back of the boiler, both pivots being, of course, the same distance above the rails and on the vertical center line of the engine. After several trials, points of suspension were found which were in line with the center of gravity, which, as thus determined, was found to be 50½ inches above the top of the rail. As the bearing points of the drivers on the rails are about 56 inches apart, the base on which the engine runs must be 1.1 times as wide as the height of the center of gravity of the engine above the rails. It is evident from this test that the center of gravity of such a locomotive could be raised still higher without endangering the stability of the engine under the ordinary conditions of service.

A COMPARISON OF MARINE-ENGINE AND LOCOMOTIVE HORSE-POWER.

In order to secure a basis for comparison of the power of a modern freight locomotive with that of a modern steamship, we have chosen the greatest vessel of them all, the Oceanic. This truly gigantic ship, which exceeds the Great Eastern in length and in displacement, is 704 feet in length, and on a draft of 32½ feet displaces 28,500 tons. As the depth of water in the entrance channels to New York harbor will not accommodate a vessel drawing that amount, for the purpose of this comparison we will suppose that the Oceanic is drawing 30 feet, at which draft she would displace about 26,000 tons. On this displacement her engines will indicate about 28,000 horse-power when driving the vessel at a speed of 22 land-miles an hour.

Now, it is estimated that the big Rogers Consolidation could haul about 3250 tons weight of train at a speed of 22 miles an hour, on the level, and that while doing this work it would indicate about 1760 horse-power. Here then we have a basis of comparison, and we may apply it in two ways. Either we may ask how many of these locomotives would have to be crowded into the hold of the Oceanic, and coupled to her main shafts, in order to drive her through the water at 22 miles an hour, or we may determine how many of these locomotives it would take to haul the Oceanic if she were placed upon a movable cradle of the kind designed by Captain Eads for his Tehuantepec Ship Railway. In the first case, we know that when the main shafts of the Oceanic are making about 90 turns a minute, the engines are indicating about 28,000 horse-power, which is their maximum capacity. On the other hand, we know that when the drivers of one of these locomotives are making about 150 turns a minute, and the maximum tractive effort is being exerted at the periphery of the wheels, it is indicating about 1760 horse-power, which represents its possible maximum indication at that speed. If now the sixteen necessary locomotives (the number being found by dividing the horse-power of the ship by the horse-power of the locomotive) were arranged in two lines, one above each main shaft, and the tractive effort of the drivers transmitted by means of friction wheels to the shafts, the speed of the rotation being reduced by intermediate gearing, in the ratio of 150 to 90, we should have the conditions required.—*Scientific American.*

STEAM ELECTRIC LIGHTSHIP FOR CAPE HATTERAS.

A few miles off the shore of Cape Hatteras are the justly dreaded Diamond Shoals, on which futile attempts have been made to erect a lighthouse. Something over a decade ago the contract was let to a large and experienced contracting firm in this city for the sinking of a huge caisson into the sandy bed of the shore upon which to carry the proposed structure. The caisson, however, was wrecked and the failure seems to have discouraged any further effort. It would seem as though the only practicable way to protect shipping is to moor a lightship above the shoals and this has been attempted. The last vessel to be placed there was recently torn from its moorings during a heavy gale, and it became evident that a ship of special design was necessary to meet the exceedingly trying local conditions. Such a vessel has been designed and is now nearing completion at the yards of the Fore River Engine Company, of Massachusetts. She will be steam-propelled and electric-lighted, and when completed she will be one of the first, if not the only one, of her kind ever launched. The government contract calls for a vesssel 112 feet between perpendiculars, with a molded beam of 28 feet 6 inches, and a depth of 14 feet 10½ inches measured from the main deck beams to the top of the keel amidships.

The vessel will have three decks, the main and spar decks running full length of the ship, while the lower deck is broken by the forward coal-bunker and the after bulkhead of the engine-room. The hull will be divided by water-tight steel bulkheads into five compartments, and the quarters and storerooms are so arranged as to meet all requirements of safety and comfort. The dynamos and engines for the electric-light plant will be located on the main deck, as shown, and within the engine and boiler casing. The accommodations for the crew are forward on the main deck. There will be two hollow steel masts, through which the wiring for the masthead flashlights is to run. These lights, three in number on each mast, are to be adapted for electricity or for oil lamps. The cluster mast headlights will be 59 feet above the water-line, the measurement being taken from the 12-foot water-line to the focus of the lamps.

The electric plant will be driven by two non-condensing, double-cylinder engines, running under a steam pressure of 80 pounds to the square inch. The vessel will be lighted by eighty 16-candle-power 100-volt lamps, which will be placed where necessary throughout the ship. The mast-head cluster will consist of six 100-candle-power 100-volt lamps, and these lights will be controlled by an automatic flashing device. It is driven by means of a belt from the dynamo shaft, and a worm and worm-wheel which serve to give the proper rotary speed to a circuit-breaker. The lightship will be propelled by an inverted, surface-condensing, single-cylinder engine of 250 indicated horse-power, with a cylinder 23 inches in diameter by 22-inch stroke, driving a cast-iron propeller 7 feet 3 inches in diameter. Steam will be supplied by two straight, cylindrical, tubular boilers, 9 feet by 16 feet 7½ inches, with a working pressure of 100 pounds to the square inch. The deck fittings of the vessel are flush, with a view to presenting as little surface as possible to the action of wind and water.

When No. 72 is on her station off the treacherous Hatteras shoals her mooring tackle will consist of a heavy mushroom anchor, shackled to a chain which leads through the main hawser hole in the stem of the ship to a steam windlass. In addition to this mooring tackle, the vessel will have a 2000-pound harbor anchor, a kedge weighing 340 pounds and 120 fathoms of 1⅛-inch stud-link chain, with a breaking strength of 79,100 pounds. Amidships, on either beam, will be swung two whale-boats of about 26 feet length and 6 feet beam.

The spar deck is protected by a gradually rising steel waist, which starts flush a little forward of abreast the foremast, flaring somewhat at the knightheads until at the stem proper it has a depth of 5 feet. In addition to the steam whistle, the lightship is provided with a steam siren which is fitted just forward of the smokestack for use in thick and foggy weather.—*Scientific American.*

THE IMPERIAL JAPANESE BATTLESHIP ASAHI.

Although she differs considerably from the Shikishima in appearance, the Asahi is practically a sister ship, the sole points of difference being (1) funnels; (2) distribution of the 2½-pounders; (3) absence of a bow torpedo-tube; and (4) mounting of the big guns. There are, of course, certain minor structural differences—such, for instance, as the fact that the Asahi has a slightly larger ward-room, and that this ward-room is a trifle further aft—but, generally speaking, for fighting purposes they are identical save for the points of difference noted above. There are unseen differences of detail also, such as the thickness of the armor deck, but none of these affect the fighting value. There is a difference, too, in the coal carried, but coal capacity does not show to the eye.

The details of the Asahi, with those of the Shikishima and the British Formidable, are as follows:

	Asahi.	Shikishima.	Formidable.
Displacement	15,200	14,850	15,000
Material of hull	steel	steel	steel
Length, feet	400	400	400
Beam, feet	75½	75½	75
Draft, feet	27½	27¼	26¾
Guns—12 in.	Four 12 in. Mark IX. for all		
6 in.	14	14	12
3 in.	20	20	16
Smaller	6 3-pdr. 6 2½-pdr. 8 Maxims	6 3-pdr. 6 2½-pdr. 8 Maxims	12 3-pdr. 8 Maxims
Torpedo tubes, submerged	4	4	4
Torpedo tubes, above water	0	1	0
Armor belt, inches	9	9	9
" at ends, inches	4½	4½	3
" deck, inches	4	5	3
Lower deck, inches	6	6	9
Casemates, inches	6	6	6
Barbettes, inches	14	14	12
Bulkheads, inches	14	14	12
Armor material	Harvey nickel, all three		
I. H. P., forced	15,000	14,500	15,000
Boilers	Belleville, all three		
Speed (contract)	18	18.5	18
Coal (normal)	(?) 1,400	700	900
Screws	Two in all three		

There is some doubt about the Asahi's coal, 1400 tons may be the maximum and 700 the normal. Japanese ships do not need to carry much coal, being designed to operate in waters where friendly coal stations are numerous. True, ships thus kept short are likely to be out of action because they are coaling, about once a week, but on the other hand, as they get two extra 6-inch quick-firers, and four 12-pounders for this sacrifice, they are rather envied by our naval officers. After all, the primary duty of a battleship is to hit the enemy hard, and an extra 6-inch in the broadside is no mean advantage. There are other incidental advantages too—a single 6-inch shell would put all the eight 12-pounders out of action on the upper deck of the Formidable, while, thanks to the casemates acting as screens, the Asahi could only lose two of her 3-inch by a single shell. In the placing of her 3-inch guns she is altogether better off than the Formidable, as a comparison of the plans will indicate, the sole point in which the British ship is better off being the four guns carried on the main deck forward. The Formidable can fight all these on the broadsides, it is doubtful if the Asahi could, because of the blast from the big guns firing above them. But *per contra* she has her other 3-inch quick-firers much better placed; they are more distributed. The positions of these are: Four on the main deck forward; four on the main deck aft; four on the upper deck amidships; two on top of the forward upper deck casemates; two beside the fore conning-tower; and four beside the after conning-tower; a total of twenty. Those of the Shikishima are placed in exactly the same fashion. Those of the Formidable are: Four on main deck forward (extreme bow); four on main deck aft; and eight on upper deck amidships; a total of sixteen. Three units instead of six; or, to put it another way, work for only three shells instead of six shells. The Asahi is an improvement on the Shikishima in the matter of the 2½-pounders, a very small detail. In the Shikishima these are grouped on top of the amidship upper casemates; in the Asahi only two are over these casemates, the other four being distributed, a couple on each bridge. Two theories are at work here, and it will need a war to say which is the better. In the Shikishima it is easy to concentrate three 2½-pounders on a single torpedo-boat or portion of a big enemy, while, as a price for this, they are at the mercy of a single shell. Those of the Asahi are not thus at the mercy of one shell, but it will be far less easy to concentrate them.

The next point of difference between the Shikishima and the Asahi is that the former carries a bow above-water torpedo-tube, with 6-inch Harvey nickel protection to it. This tube, similarly protected, is in the Fuji, Yashima, Asama, Tokiwa and Yakumo. After some experiments and practice the Japanese authorities decided that this tube was of no use practically, and decreed its abolition. That of the Shikishima had, however, already been built in, so this ship has it. It is absent also on the Hatsuse, a sister, and in the Iwate and Idzumo.

Under certain circumstances such a tube might be of great use in action; for instance, approaching an enemy who presented his broadside while the ship possessing the tube wished to make a feint to ram. But to use it, it would be necessary to slow down or reverse engines—both things that might be awkward to do in an action. Still the real objection does not lie there, so much as in the trouble with sea that a bow tube causes. Bow guns, even high up, are always liable to get "washed out," a bow torpedo-tube is still more likely to be so. In addition to this, it raises an unnecessarily large bow wave.

In comparison with the Formidable, the Asahi and Shikishima have, beside the 6-inch and 3-inch guns, other points of distinct difference. They have: (1) Complete instead of partial belts; (2) 6-inch instead of 9-inch armor protecting the lower deck; (3) much higher barbettes; and (4) quite differently shaped hoods to the big guns.

Of these differences the armor one is of no immediate moment at present. The Asahi, in the matter of armor, is practically a Majestic with 3 inches stripped off the lower deck amidships and disposed on the ends plus some extra armor paid for in the weight of coal carried. Now, the 6-inch lower deck armor of the Asahi is proof against any 6-inch projectile at any range; and though a steel-pointed 9.2-inch common shell has been through 6-inch Harvey nickel at Whale Island, this is probably an isolated proving-ground case, and nothing but an armor-piercing shell of large caliber is ever likely to get through such armor in actual warfare; and it is at least doubtful whether such a shell would do more harm than a solid shot, and against a 12-inch solid shot 9-inch armor is no more protection than 6-inch. In either case the shot will go through and dance about inside, and it is this "dancing about" that makes shot dangerous, and all armor save the very best a snare and a delusion so far as solid projectiles are concerned. However, medium armor is imperatively needed to keep off shells, for it is good-bye to any ship inside of which a big common shell is comfortably planted. The Admiral class, for instance, would do no more fighting once a big common shell got them amidships.

As for the complete belt, the Formidable, of course, has something on the bow, and this may be considered proof against 6-inch shell in action, save at short range. It is, at any rate, proof against the deadly little shell from 12-pounders and the like. As for any 6-inch shot—well, very few 6-inch shot are carried in any ship, and holes made by them are easily plugged.

The real gain of the Asahi is the extra gun power, but since it is held essential that British ships shall have a large coal supply, it is useless to decry the Formidable over the two missing 6-inch guns. The defect of the Formidable, and one that might have been remedied, is the position of the 12-pounders. These could and should have been either more distributed, or else placed right up above everything and clear of everything, much as the French place their 4-inch quick-firers. Such a gun is extremely unlikely to be actually hit, whereas if it is crowded about with bulwarks, boats, and so on, a shell coming anywhere near is bound to burst with devastating effect.

In appearance it is difficult to tell the Asahi from our Canopus class, save for color. A critical eye could detect the much higher barbettes of the Japanese vessel and their different shape, but that is about all, for the extra casemate would hardly be visible at any appreciable distance. Like the Canopus class, the Asahi has the huge after funnel, and the resemblance is increased by the tautness of her masts. The sign manual of a British man-of-war is the rake forward of the top masts, in the smartest Channel fleet ships this is most noticeable; but the Asahi also is taut.

The Asahi has a slight sheer forward, like all our new ships, in consequence of which, though both pairs of guns are at the same height above the water, the after barbette looks a good deal higher than the fore one.

The shields are peculiar—sloping fronts but straight sides. The British pattern slopes all round, and is generally more squat, and of the two is more favorably regarded afloat. If by any off-chance a big shot hit the side of the Asahi shield it would get through, from the inclined sides of the British pattern it would rebound at any range. However, a shot is very unlikely to hit the sides of the shield, and probably the mere shock of a big projectile would effectually displace everything and put the turret out of action. Wherever a big projectile hits it must do some harm, whether it gets through or not, and the old American idea of battering in preference to penetration is not so unsound as many folk are now disposed to regard it. Especially must this be so with certain foreign-built ships—the least little thing wrong and the colossal blow will find it out.

The guns and mountings of the Asahi are from Elswick. They embody some slight improvements upon those of the Shikishima, but are on exactly the same general principle. The 12-inch can easily do a round a minute, and should be able to do a round every two minutes in action. The rate of the 12.5-inch Canet gun at Yalu was one round per sixty minutes, but there were special circumstances involved. Still there is no doubt that big guns have made enormous strides towards quick-fire in the last year or two, and two of the Asahi or Formidable 12-inch are equal to three of those in the Majestic probably.

The Asahi is fitted with the Barr and Stroud transmitters, each casemate having an indicator, in English and Japanese, to give the range automatically from the conning-tower. The official British view is against these transmitters, on the ground that action will derange them; but there is no getting away from the fact that, even so, till deranged they will be exceedingly useful. Our methods of passing the range are cumbersome, and, in addition, by the time it is passed it has probably altered. Moreover, gunnery is not so much a matter of good shooting as knowing the range; the wrong range given accounts for most misses, at any rate in the British navy.

All the hoists in the Asahi are electrical, with auxiliary hand-power in case of need.—*The Engineer.*

JAPANESE TORPEDO-BOAT DESTROYERS.

Length, 210 feet; beam, 19 feet 6 inches; draft, 7 feet; engines, 5700 I. H. P.; speed, 30 knots.

Six of these vessels are of steel throughout, building at Thornycroft's Works.

The propelling machinery consists of two complete sets of engines of the type invented and patented by Mr. Thornycroft, driving twin-screw propellers, each set having one high-pressure, one intermediate and two low-pressure cylinders, supported on steel columns somewhat out of the perpendicular, and so arranged that the thrusts of the rods simultaneously act on the cranks from opposite directions, in order to obviate vibration in working. In addition to the propelling machinery with condensers, circulating pumps and engines, air and feed pumps, there are fitted the blowing engines, steam steering engine, air-compressing machinery, electric-light machinery, and distilling machinery. Three of Mr. Thornycroft's patent water-tube boilers are fitted in each vessel, which give ample steam, and are remarkably efficient in respect of its rapid generation.

These boilers are fitted respectively with automatic feed regulating gear, which regulates the supply of feed water (a steel float fitted in the upper barrel of the boiler automatically opening or closing the valve through which the boiler is filled). Each boiler is capable of being worked independently, and adapted for a working pressure of 220 pounds per square inch. The armament of each vessel consists of one 12-pounder 40-caliber quick-firing gun, and five 57-millimeter quick-firing guns, also torpedo gear, consisting of two revolving tubes placed on deck aft, arranged for discharging 18-inch Whitehead torpedoes.

The full complement of each vessel of all ranks is 54 men, and the accommodation provided for them is: One commander's cabin, one wardroom, two petty officers' cabins, three compartments for crew.

The six Yarrow boats are 10 feet longer, 1 foot more beam, and about 1 knot more speed than the above.—*Engineeirng.*

JAPANESE FIRST-CLASS TORPEDO-BOATS.

The Japanese government, having determined to increase their torpedo-boat flotilla, after considering the various designs submitted, decided upon adopting the one proposed by Yarrow & Co., Limited, and they placed an order for 10 first-class torpedo-boats with this firm last year. These vessels are 152 feet 6 inches in length by 15 feet 3 inches beam. They are single-screw boats. The contract speed is "not less than 27 knots with a 20-ton load," and a probable speed of 25 knots with the full load of 44 tons.

The vessels are built of mild steel, each being divided into ten compartments, which compartments are devoted to the machinery and crew space, as customary in this class of vessel, there now being little difference in the system adopted by various naval powers as regards the distribution of the load. The turtle deck extends from the bow for some length aft.

There are two boilers of the Yarrow straight-tube type, designed for a working pressure of 220 pounds per square inch, and capable of supplying steam for 2000 indicated horse-power, with an air pressure in the stokehold of about 1¼ inches. The main propelling engines are of the three-cylinder, triple-expansion type, balanced on the Yarrow system, to minimize the vibration. The cylinders are 18 inches, 26 inches and 39½ inches in diameter, with a stroke of 18 inches, and designed to run up to 400 revolutions per minute.

The vessels are lighted throughout by electricity.

The coal-bunkers hold 32 tons, which is sufficient to take a vessel of this size across the Atlantic, two sister ships having navigated from London to Valparaiso.

The armament consists of one 14-inch Whitehead torpedo-tube built into the bow above the water; one revolving torpedo-tube on deck, about one-third of the length of the vessel aft of the stem. This tube revolves about an axis in the middle line of the boat, so that the tube can be discharged over either side. A similar 14-inch torpedo-tube is provided aft. There is a water-tight torpedo-room under the forward crew space suitable for carrying three reserve torpedo bodies, the war-heads being stowed in a separate magazine. The reserve torpedoes are lifted either direct to the bow tube or transferred on a small trolley along a tramway on the deck arranged in such a way that the torpedo can be placed in either of the central tubes. There is a 2½-pounder quick-firing gun right aft with an almost all-round radius of fire.

The searchlight is placed on the conning-tower.

Although the armament above described was adopted after careful consideration by the Japanese authorities, it is by no means the limit for a vessel of this class, a much heavier armament having been carried on five similar boats recently constructed by Messrs. Yarrow & Co., for the Austrian navy, *i. e.*, two 18-inch Whitehead torpedo-tubes, one on each gunwale abaft the conning-tower forward, and one 18-inch torpedo-tube aft, two reserve torpedoes in the torpedo-room, and two 47-millimeter quick-firing guns, one on each side of the conning-tower.—*Engineeirng.*

There was launched on March 29, from the Elswick Shipyard of Sir W. G. Armstrong, Whitworth & Co., the Japanese first-class armored cruiser Iwate. The Iwate is a sister ship of the Asama, which was launched from the same yard some time ago. The principal dimensions of the vessel are: Length between perpendiculars, 400 feet; breadth, 68 feet 6 inches; depth, 41 feet; draft, 24 feet 3 inches; displacement, 9750 tons. The armament consists of four 8-inch breech-loading guns twin mounted in barbettes; fourteen 6-inch quick-firing guns in 10-inch casemates, six on the main deck and four on the upper deck, the remaining four being on the upper deck protected by shields; twelve 12-pounder quick-firing guns; and eight 2½-pounder quick-firing guns. There are four submerged torpedo-tubes, two forward and two aft. The vessel has a complete water-line belt of Harveyed nickel-steel armor, 7 inches thick, amidships and reduced at the ends. Above this there is a citadel of 5-inch Harveyed nickel-steel armor enclosing the bases of the barbettes and carried from the top of the water-line belt to the main deck. The barbettes are of Harveyed nickel-steel 6 inches thick. The casemates are of nickel-steel 6 inches thick. The conning-tower is Harveyed nickel-steel 14 inches thick. The machinery is of the twin-screw vertical triple-expansion type, and is to develop 14,500 indicated horse-power. The speed guaranteed is 20¾ knots, and the boilers are of the Belleville latest type. The vessel has a bunker capacity for about 1600 tons of coal. Accommodation is provided for an admiral, 52 officers, and 430 petty officers and men.—*Engineering.*

SHIPS' ARMOR.

Lord Hopetoun says that two courses are open to the government. "Either to extend by means of orders guaranteed over a series of years, the number of firms capable of supplying armor-plate; or for the state itself to undertake its manufacture." He goes on to say that "the latter course is open to serious objections," an opinion to which nearly all who have studied the subject will subscribe; and we think that had Lord Hopetoun realized how very serious the objections are, he would hardly have put forward the proposal of a state armor factory, even as a remotely possible alternative; so long, that is, as there are private makers willing to lay down the plant needed for any possible need of the fleet.

Our Admiralty investigated this question of state supply many years ago and decided in favor of private manufacture.

It will be interesting to look abroad and see what has been done in countries where the possibilities of private supply are far below our own. The question was well considered in the United States three or four years ago; for, as is well known, the American government authorities have had a good deal of trouble in getting their armor supplies, and, indeed, recently came to a complete deadlock.

In the official report of the Chief of the (United States) Bureau of Ordnance for 1897, the question is dealt with very completely, and the opinion is definitely expressed "that the (United States) government can purchase armor more cheaply than it can manufacture it." The Ordnance Bureau rightly regarded "the making of armor as a proper adjunct to a great commercial steel plant. . . . Should the department acquire a plant of its own, the chances are that it would be at a great cost, and that it would lie idle a large part of the time, and thus suffer deterioration, and that the expense and difficulty of operating it when needed would more than offset any advantage gained by such ownership."

In a publicataion issued by the American Iron and Steel Association, it is stated that "every naval power of Europe has, at different periods since the advent of the armor-clad ship, contemplated government manufacture of armor. The government factory erected by the Russian government near St. Petersburg is, we believe, the only establishment of the kind belonging to any naval power. The plant is said to be still incomplete, and has cost from four to five millions sterling. It is conceded that armor can never be made there at as low a price as it could be purchased from abroad; a statement no one will be likely to question." The measure was, however, but a part of a policy that the Russians have always pursued; namely, to make the nation as self-contained as possible in regard to warlike supplies. As a matter of fact, the Russians are still large customers to foreign armor-plate makers, the American makers having profited largely by their custom, and the vast expense of the Kolpino factory is excused on the score of it being a reserve establishment to be brought into play upon the outbreak of war when foreign supplies might be cut off. The explanation is somewhat lame. The nation that trusts to laying down ships and making armor when war has been declared, would be pursuing a course far more foolish than the shrewd Russians are likely to contemplate. The real point of interest for us at present is whether the Russians might not have better encouraged home industry and strengthened the military resources of the country more effectually at the same time by spending an equivalent, or a far smaller sum, in guaranteeing a continuance of orders to private firms.

Some interesting figures relating to the assumed cost of an armor-plate factory were given in a letter of the Secretary of the United States Navy in 1897, quoting the opinion of the Chief of the Bureau of Ordnance. The sum of 300,000*l.* had been estimated as the price of a plant needed for the purpose. This is described as "quite inadequate"; and the obvious fact is pointed out that a plant for armor-making must comprise a steel-making equipment also. To obtain the necessary stock of material for working on a large scale, and for the unavoidable experimental work in the beginning, 600,000*l.* would be required. The Carnegie armor plant was at that time said to have cost that amount, and it has increased since then.

This country, however, stands on quite a different basis to either the

United States or Russia, but whatever arguments are to be advanced in favor of private manufacture with those, or, indeed, any other nations, are of considerably more weight in regard to Great Britain. We are far from agreeing with those perhaps somewhat short-sighted enthusiasts who say "the navy must have the very best of everything, no matter what it cost"; for cost is necessarily a very ruling factor, not only in a naval programme, but in the design of ships. In this case, however, cost is a minor consideration, and if private makers were not to be trusted to make the best kind of armor, we would be prepared to advocate considerable pecuniary sacrifice. There is, however, hardly a shadow of doubt that the result would be quite in the opposite direction. No doubt a government factory would produce in a leisurely manner excellent armor of ten or fifteen years' antiquity, and we should see the private firms of the country supplying plates for foreign ships that would be far more resistant to shot and shell than those being placed on the sides of the ships of the Royal navy.

We say we should see our private firms supplying armor to foreign powers, but the statement needs perhaps some consideration. Some of the foreign powers are making very rapid strides not only in armor-plate making, but in other branches of steel manufacture. England once held the palm in this field both for inventive ingenuity and boldness in carrying inventions to a practical issue. That former activity has placed us in the position we yet occupy in this field. But we are, it must be confessed, somewhat trading on the past, and no longer hold our old undisputed supremacy. Compound armor was an English invention; it inaugurated the principle upon which all modern armor is made, of a hard and, therefore, comparatively brittle face to resist penetration, in conjunction with a tough and softer backing to hold the mass together and prevent breaking up. Since then, however, further advances have been due to the inventors of other countries, and our armor-plate firms have been dependent on their labors. The Harvey process came to us from America, and now we have the further improvement introduced by Krupp.

It may be said that this being the case, there is little reason for encouraging the private firms. They have not made advances, therefore a government department could not be more stationary; for, of course, no one expects government factories to inaugurate improvement. That would be mortgaging the future, and, as a matter of fact, the English makers have made improvements, though they have not of late effected a quite new departure. But, beyond this, that notable advances have been made abroad is a very cogent reason why a government factory should not be trusted with the supply of armor. Governments are influenced by political considerations, and for a public department to adopt a foreign invention is to bring down on it an amount of hostile criticism which few governments would be courageous enough to withstand.

We have had notable instances of this in the past; but to those who are acquainted with the manner in which government factories are managed, it needs no recital of examples to show that they move out of established grooves only under the influence of great external pressure. With the incentive towards gain, the proprietors of private works are ready to adopt suggestions that will place them ahead of their rivals; and, therefore, putting aside the labors of the proprietors of the establishment themselves, a member of the staff, or an outside person, bringing forward a promising suggestion, is eagerly welcomed; that is, of course, supposing there is sufficient competition, as there always should be, in the case of government supplies. On the other hand, the energetic or ambitious subordinate in a government factory knows very well that if he has fresh ideas that will entail thought, hard work, and some responsibility in their working out and adoption, he had better keep them to himself, even if the jealousy of those over him be left out of account.

There is in England no need for a government armor-plate factory. The private firms are quite willing to find all the money and enterprise needed for keeping up the supply, if they are given reasonable encouragement. It is well known that one at least of these firms made an offer some time ago to the Admiralty of increasing their plant to any desired extent, if they were insured a continuance of orders for a very moderate period of time; and other firms, we believe, were quite ready to go on the same lines. Whether it was Treasury obstructiveness, or whether it was some other cause, only those in the confidence of the government could state; but at any rate this reasonable proposal was not entertained. Of late we have been doing better. Vickers's have added a third firm to the big Sheffield armor-plate makers, and Armstrong's have nearly completed a splendid new plant at Openshaw. This will enable the powerful northern firm to make the protective plates for the ships they build with such success at Elswick. At Glasgow, Bardmore's are also capable of turning out certain descriptions of armor.

That these companies should receive encouragement is a matter of national importance. As we have said, there are foreign rivals in the field, and it is, above all, desirable that all fair encouragement should be given to our home makers, to enable them to hold their own. A full volume of trade is the greatest source of strength in the case of a manufacture entailing the laying down of such immensely costly plant, and the employment of highly specialized and exceedingly well-paid labor. The foreign trade we do in ships, guns, and, indeed, all war material is one of our chief sources of military strength, and all legitimate encouragement should be given by the government to this branch of industry, without thought whether the things produced may or may not be turned against us at some future time.

We have said that English makers of armor-plates have made improvements of late, and this fact is well brought out in a paper read last week before the Royal United Service Institution by so good an authority as Captain Orde-Browne. He made reference to the Krupp process, which he says "is no doubt subject to variation, and since it has been adopted in this country, each maker has improved and modified it." As is well known, the English makers, as well as the Americans and French, have all taken licenses from the firm of Krupp. In a table given by Captain Orde-Browne in his paper, results of firing trials at various plates made on the Krupp system are given. From these is seen how notable has been the success of John Brown & Co., the founder of which firm made the first armor-plates in this country, and of the American Carnegie Company. These two firms, which practically are equal, have a better figure of merit for their plates than is credited even to those made by Krupp.

The features of the process are secret, and the secret is well kept, though in so many hands. According to Captain Orde-Browne—although he speaks not without reservation—the process "consists mainly in the use of chromium to such an extent that great brittleness and hardness might be expected. Sudden cooling is carried out in a way that might be expected to ruin the metal, but the result is great toughness. It must be understood, however, that nickel is also used, and nickel has long been known to give toughness in a remarkable degree."—*Engineering.*

THE NAVY ESTIMATES.

The total net estimates for the coming year reach the imposing figure of 27,522,600*l.*; which is nearly a million more than the estimates for the present year. We give in the table below an abstract of the net estimates on the different votes for the present and preceding five years. This shows very clearly the growth of naval expenditure. It will, of course, be understood that the differences between gross and net estimates are represented by appropriations in aid, and we have, therefore, not considered it necessary to give the gross estimates in our table.

The new programme of shipbuilding provides that there shall be laid down during the coming year two battleships, six first-class armored cruisers, one second-class cruiser, two sloops, two light-draft gunboats, and two torpedo-boats. Of these, the two battleships, two of the armored cruisers, the second-class cruiser, and the two sloops, will be built in the dockyards; so that, putting aside the four boats, only four cruisers are to be given out to contract. Considering the failure of contractors to meet the programme, it was to be expected, and, indeed, inevitable, that the major part of the new construction should be carried out by government establishments. On the whole programme, however, the value of work to be done under vote 8 is almost equally divided between the dockyards and the contractors, the former being allotted construction which is to cost 6,596,000*l.*, while there is to be spent on contract work 6,329,000*l.* The full list of ships that will be in hand is one of considerable magnitude, consisting of no less than 77 vessels of various sizes, of which 17 are battleships and 20 armored cruisers. The other 40 are made up by one first-class protected cruiser, two second-class protected cruisers, one third-class cruiser, eight sloops, two light-draft gunboats, four torpedo-boats, 21 torpedo-boat destroyers, and one Royal yacht. The whole forms a list that would be a respectable navy for most foreign powers; but it is not a ship too many.

As will be seen by our table, five years ago, when the present government came in, the total amount of the navy estimates was 18,700,000*l.* The next year there was an advance of over three millions, next year about half a million, the next year nearly one and a half million, the next year—the present, 2,800,000, and for the coming year the advance, as stated, is not quite a million. If, therefore, we consider the political outlook of the present moment, the estimates now brought forward are certainly moderate, unless those of the past few years have been altogether extravagant. No one considers, excepting a few peace-at-any-price fanatics, that the naval estimates have been excessive. Probably the spending of these extra millions has been the most economical step the nation has ever taken. Large as is the cost of a navy in peace, it is a trifle to that in war.

It will be seen that the largest increase in the estimates is for personnel, the votes for which absorb not far from half the total excess. The num-

TABLE SHOWING NET AMOUNT OF VOTES FOR NAVY ESTIMATES FOR THE COMING AND FIVE PREVIOUS YEARS.

Vote.	YEAR.	1895-1896	1896-1897	1897-1898	1898-1899	1899-1900	1900-1901
	EFFECTIVE SERVICES.	£	£	£	£	£	£
1	Wages of officers, seamen, and boys, coastguard, and Royal marines	4,133,500	4,419,800	4,696,000	4,988,000	5,242,700	5,527,000
2	Victualling and clothing for the Navy	1,367,100	1,369,600	1,384,600	1,491,700	1,606,700	1,715,300
3	Medical establishments and service	151,400	156,200	161,400	167,000	176,600	208,800
4	Martial Law	10,600	10,600	10,600	11,400	12,200	13,300
5	Educational services	79,400	81,300	85,600	86,600	90,600	92,300
6	Scientific services	61,400	63,300	66,700	67,200	69,500	66,900
7	Royal Naval Reserves	215,600	229,800	249,900	257,000	271,000	271,100
8	Shipbuilding, repairs, and maintenance:						
	Section I.—Personnel	1,810,000	1,104,000	2,126,000	2,218,000	2,417,000	2,512,000
	" II.—Materiel	2,655,000	2,251,000	2,064,000	2,971,000	3,799,000	4,084,000
	" III.—Contract work	3,416,000	5,386,000	5,440,000	5,612,000	6,601,000	6,329,000
9	Naval armaments	1,693,200	2,543,200	2,775,000	2,549,200	2,710,800	3,004,700
10	Works, buildings, and repairs at home and abroad	547,000	618,400	648,800	650,100	795,100	845,800
11	Miscellaneous effective services	176,800	189,200	195,400	232,900	248,200	271,200
12	Admiralty Office	237,200	236,800	243,600	247,700	261,000	267,100
	Total effective services	16,554,200	19,656,200	19,697,600	21,549,800	24,302,000	25,208,500
	NON-EFFECTIVE SERVICES.						
13	Half-pay, reserved, and retired pay	761,300	749,000	749,500	752,500	774,700	786,700
14	Naval and Marine pensions, &c.	1,007,900	1,030,100	1,053,200	1,082,900	1,116,000	1,123,600
15	Civil pensions and gratuities	317,300	324,400	327,400	332,900	341,500	343,500
	Total non-effective services	2,086,500	2,103,500	2,130,100	2,168,300	2,232,200	2,253,800
	EXTRA ESTIMATE.						
16	Additional force in Australasian waters—annuity payable under	60,300	60,300	60,300	60,300	60,300	60,300
	Grand total	18,701,000	21,823,000	22,338,000	23,778,400	26,594,500	27,522,600

ber of officers, seamen, boys, coastguard, and royal marines for the coming year are 114,880; as compared to 110,640 of the present year. With the resources of the country in shipbuilding and engine construction employed to their fullest extent, the question of manning such ships as we have naturally comes to the front. In former years, when the navy was more the shuttlecock of party than at present, personnel received but small attention at the hands of the parliamentarians who ruled in the councils of the nation. The reason was that a big programme of new ships was taken as the criterion of naval progress, no matter whether the vessels were to be manned and gunned or not. The public are better instructed now and have learnt to look more critically at the naval programme.—*Engineering.*

OUR NEW GUNS AND AMMUNITION.

Our manufacture of guns goes on satisfactorily, especially that the new 9.2-inch and 7.5-inch guns will soon be completed, the former for issue, the latter for trial; and further, that the conversion of our 6-inch guns into quick-firers will soon be completed in all ships that are considered worth the expense, and for reserve batteries and drill ships, and that their supply of cordite will be complete at the end of the present year. This is fairly satisfactory. The new guns are very powerful of their type, representing an extreme development of length of bore and high muzzle velocity, and great power of penetration through armor. This type has been developing for many years. England is well represented by these pieces, and England alone has actually in the service any number of guns of wire construction, Russia and America having apparently ceased their efforts in this direction. It will probably seem barbarous and retrograde to object to the form of development which our new type of guns have taken. Without going so far as this, we think that we should guard against being drawn into false directions. These individual guns may be needed; in fact, the 7.5-inch gun is, we think, a necessity in more than one way. That is to say, not only shall we soon need a quick-firing broadside gun of greater power than our 6-inch guns, but the piece must be one of somewhat the actual proportions assigned to the 7.5-inch gun. It must, in fact, have considerably greater penetration than the present 6-inch gun if it is to perforate 6-inch hard-faced armor, while, at the same time, the weight of the projectile must be kept down as much as possible if we are to load and fire quickly. This shuts us up to a small bore, and the gun must be a long one, with high muzzle velocity. We understand that about 3000 foot-seconds is talked of; this, with a 200-pound projectile, gives a muzzle energy of 12,480 foot-tons, with a perforation through 32 inches of iron. This is an enormous result, but we have no hesitation in saying that while the gun is right, so far as it can go, that any one who expects this to be realized on service will be entirely disappointed, because while this velocity may be got perhaps with a new gun, it will rapidly fall with the range, and because the bore of the gun will very soon wear, and thus the muzzle velocity will drop very considerably.

Lieut. Meigs, of Bethlehem, has recently raised the question whether these small bores with high velocities are not an unprofitable form of energy, and we are forced to agree with him. That is to say, velocity in a shot resembles speed in a ship in the fact that we pay very heavily for it in more than one way. On paper, such a gun as this appears admirable.

Considered as a 7.5-inch piece, the results are, indeed, splendid; but this way of taking the calibers as the standard of comparison is misleading. The gun, we are told, will weigh 17 tons, and we have always maintained that the weight of metal represents the capital invested, as it were, and the possible work is proportionate to it. The heaviest 8-inch gun of new type weighs only 15 tons. The old obsolete 10-inch muzzle-loader weighed but 18 tons, with a projectile of more than double the weight of that of the 7.5-inch gun, namely, 410 pounds. The energy was only 5408 foot-tons, but the same metal could now be employed much better with slow-burning powder, and a much better ballistic result obtained. The comparison of what we have in this new 7.5-inch gun with what might be got with a larger projectile, and a muzzle velocity of, perhaps, 2000 foot-seconds, would, be believe, show the latter to be much more profitable and trustworthy, both range and continued firing telling much less against the gun. We may say at once that the alternative is not allowable in this instance, because the larger projectile could not be loaded so fast nor penetrate so much, and we require all the perforating power we can get; 32 inches of iron sounds enormous, but this would not mean more than 10 inches of Krupp process armor and an angle of impact of 30 degrees from the direct line, and the fall of velocity from wear of bore and range would leave us even less margin than we could wish against 6-inch Krupp armor. The fact is that our guns must be made with a view to what we want them to do. As we have repeatedly said, 6-inch hard-faced steel is a most manageable thickness of plate as will be much used in future. The Colon and ships of similar class have been practically covered with such armor, and clearly we must have secondary armaments capable of perforating it even at some sacrifice. This condition does not apply to larger guns. A projectile which cannot perforate the secondary parts of an armor-clad enemy is useless, but the perforation of her belt is quite another matter. A powerful armor-piercing shell in the upper structure might often do more harm than a shot perforating the belt. Lieut. Meigs has recently been engaged in designing and constructing a heavy gun of large bore—namely, an 18-inch gun—whose weight does not differ much from that of our 12-inch wire gun. This piece would have the advantages of preserving its muzzle velocity, which is, we believe, about 2000 foot-seconds as to range, and the bore would wear much less. The bursting charge would be enormous. Against this we have to put the inconveniences of increased weight and bulk of projectiles, both in storage and loading. We need to see this interesting question practically worked out to form any real opinion, and our present point is only to emphasize the fact that our special needs as to perforation have driven our guns to take a wasteful form of energy, and we should be on the watch for any opening to take a profitable departure in a new direction, the possibility of which seems at present confined to our larger guns, and we should think specially the larger guns of our cruisers.

The conversion of all our secondary armament guns to quick-fire action is of great importance, and a good system of conversion having been arrived at, it is satisfactory to know that it will be completely carried out before long. Cordite is a special element in our system; it may be questioned if it is very satisfactory in the face of the tremendous rate at which our guns wear out. A few weeks since, we noticed the fact of our steel being slightly softer than that generally used on the continent. A much more important matter is the nature of our powder. All smokeless powders consist largely of guncotton, on which account we ought to pay a passing tribute to Austria and Baron Lenk. Guncotton requires the addition of an oxidizing ingredient—nitroglycerine being used by Germany, ourselves and others; and nitrate of baryta by Russia and the United States. The former offers the advantage of complete action, the whole of the products of combustion being gas. The latter is only semi-smokeless, and its incomplete action prevents the full development of power, but it is said to injure the bore very much less than the nitroglycerine powders, especially cordite, which contains much the largest proportion. We state the case as it is put; we are not aware of any trustworthy results obtained by comparative trials of powders. It is claimed for cordite that its erosion is remarkably even, and we know that much can be done to prevent it by special gas checks. The whole matter, however, cannot be said to be satisfactorily worked out, and it is well that we should recognize it and keep our eyes open.

As regards projectiles, in the present state of things, a good armor-piercing shell is the projectile most needed, and we may congratulate ourselves on having one. Ships will probably depend more on their heavy quick-firing batteries than on other guns; while we have 6 inches of hard-faced armor in front of the secondary armaments in our strongest ships, nearly all foreign ships have very inferior protection, so that, on the whole, we have much upon which to congratulate ourselves at the present time.—*The Engineer.*

BRITISH AND FRENCH GUNS.

Sir Charles Dilke's question in the House as to the relative powers of British and French guns has served to stimulate the misgivings which many feel as to the condition of our ordnance, though the question is here raised in a new form, since it is our heavy guns that are declared to be inferior to those of France. We fear that the First Lord's answer was calculated to foster uneasiness. When a question is asked with proper notice, a definite reply is expected. Sir C. Dilke said that "the figures quoted with regard to the French guns went to show their superiority over our own guns at every period of the shot." "Mr. Goschen thought that this was doubtful." Consequently, at best, any one fully accepting his statement can only "think doubtfully" with him. Now we are not prepared to say that a very exactly certain answer can be given, but, at all events, it is desirable to show that the scope of uncertainty is narrow, and that if there exist elements that need to be improved, improvement is not difficult of achievement, and this, we think, can be shown. Indeed, we may say at once that while we think that serious attention ought to be given to the ballistic conditions of our heavy guns and their charges, there is nothing wrong that cannot be rectified, and that in some essentials British guns are the very best. We have dealt with some elements in this question lately, but it may be well to review the matter again briefly. First, let us deal with the actuals guns themselves. The proportions of guns have been calculated for so many years, that little new can be put forward. The French certainly keep the details of their new guns as secret as possible, nevertheless no uneasiness need be felt where no surprise is conceivable. Guns achieve higher velocity as years go by, because they are made longer and heavier in proportion to their caliber. The chamber may vary in size to suit special charges, but in actual proportions the possibilities are mainly limited to obtaining an increase of velocity if we like to pay for it in the shape of increased length and weight.

The result, however, is sometimes proved to be undesirable. A few years since, very long guns for coast service were advocated by M. Canet. In the table in the *Naval Annual* for 1899 may be seen pieces 80 calibers in length. We happen to know that these have disappeared from the tables of Schneider-Canet guns for the coming number, so that this clearly illustrates our point, namely, that there is no magic in the metal structure of a gun; that any good maker can produce a gun of increased power by giving it increased length and weight; but, like our own 111-ton gun, it may be a white elephant, whose room is preferable to its company. When we say that all metal is the same, we are not speaking absolutely correctly; there is a little, although very little, difference between one and another gun steel; and much more, there is a substantial advantage which we claim in the wire or riband construction. This might be sufficient to take seriously into account, were it not that owing to reasons to be noticed presently, we are unable to avail ourselves of it. On the whole, our readers may be satisfied that as regards the actual metal the guns themselves are good, and that no surprises can await us and show us that we need new pieces. This is, at all events, satisfactory, as it means that our main provision in the way of ordnance is sound.

Guns and caliber in inches.	Length in calibers.	Weight of gun in tons.	Weight of projectile in pounds.	Muzzle velocity foot-seconds.	Muzzle energy foot-tons	Energy at 2000 yards—foot-tons	Muzzle energy per ton of gun.
British 12	40	50	850	2600	33,020	29,860	660.4
French 12	40	45.9	643.8	2625	30,750	21,020	669.9
British 9.2	46.74	27	380	2600	17,810	12,130	660.0
French 9.45	40	22.4	317.5	2625	15,170	9,354	676.2
British 6.0	45	7.4	100	2642	4,840	2,612	654.1
French 6.46	45	6.89	99.21	2625	4,730	2,302	686.5
United States, new, 12	40	52	850	2800	46,246		889.3

We must next pass on to the elements of power and projectile. For more complete comparison we give herewith a short table of the three pairs of British and French guns that seem the best and fairest representatives, namely, those of 12-inch, 9.2 inch and 9.45-inch, and lastly 6-inch and 6.46-inch caliber. We admit, as we have said, that there may be newer French designs, but these are the best available. It will be seen that our 12-inch guns are the same length. Ours weighs 50 tons and the French gun 45.9 tons. Our muzzle velocity is given as about 2600, and the French as 2625 foot-seconds. Now both these velocities are estimates, and in such estimates 25 foot-seconds difference is accidental, the fact being that the numbers are round in each case, and the French 800 meters which is given for each French gun in this table happens to be equivalent to 2625 feet in British units. Several French guns may be seen estimated to the same round number, 800 meters, in fact, all the three in these tables. The first comment to be made is that our guns appear to be unnecessarily heavy, but this is explained by the weight of projectile; ours weigh 850 pounds, and the French only 643.8 pounds, so that our gun has a muzzle energy of 33,020 against 30,750 foot-tons in the French gun. As the range increases the weight tells more, so that at 2000 yards it may be seen our projectile has 29,860, and the French one only 21,020 foot-tons energy, so that our superiority has increased from about 10 per cent to 42 per cent. The same difference is seen throughout. In each case the British guns and projectile are the heavier, and the French muzzle velocity the higher. At the muzzle, the energy per ton of gun is greater in the French shot, but at 2000 yards our projectiles have overtaken them; thus, with the 12-inch we have 597 against the French 458. In short, judging from the British and French guns in this table alone, we should say that we have no cause for complaint, and that however diffidently expressed, Mr. Goschen was right in his statement that we had the advantage at the end of the trajectory, while Sir Charles Dilke was wrong in saying that any attainable figures go to "show superiority at every period." Even at the muzzle, our shot have greater energy, so that Sir Charles Dilke's statement is literally the reverse of the truth, unless he takes the less weight of the French guns into account, which is a different question. Even so, all that can be said is that the French get rather more work per ton of gun at the muzzle, but lose this advantage even at a short range.

Having thus made out, we think, a fair case for our guns, we shall perhaps surprise our readers by saying that it is by no means the whole case, and that elements exist which force us to the conclusion that we need seriously to reconsider certain matters, though they are points not touched on in the House. It may be seen that at the foot of the table we have added a United States 12-inch gun of new design. It is not found in existing tables, but we have the figures on the best authority, that is, from the United States Bureau of Ordnance. In some respects this gun should be satisfactory to us. It may well have been copied from our own. The length is the same, so is the weight of projectile. The gun is two tons heavier. Possibly ours being of wire construction, may be as strong, so that in the actual metal there may be little to choose, or rather we may have the advantage. But now comes the point. The American gun claims 2800 foot-seconds velocity, against our 2600 foot-seconds, and this opens the question that we think calls for inquiry—the question of powder. In tables generally foreign guns will be seen claiming higher velocities than ours. There might not be much stress to be laid on this, because new guns always have high velocities, and we have already pointed out that in many cases they are estimated velocities only. Unfortunately many of us are aware that whatever foreign guns do, our own wear at a rate which causes the velocity to fall shockingly fast. As has before been said, our heavy guns go to sea with a supply of ammunition which, limited though it is, could not be fired away without the velocity and shooting of the piece falling off seriously. We doubt if all the devices in the way of gas-checks and augmenting strips of copper would carry some guns satisfactorily through 100 rounds. We are met by the statement, and we believe it is true, that no nation, except perhaps the United States, fire their guns much in peace time, consequently it is argued that their guns are not forcing this said fact of wear on their owners, simply because wear is not taking place. Nevertheless it is surely mad to assume that because we experience an evil, our neighbors, whose conditions differ substantially from ours, must necessarily suffer the same evil and to the same extent. All we know is that they do not own to it. Let us consider how we stand in the matter of powder and wear of bore. The wear has been classified under two heads, "erosion" and "wash." Erosion is the eating out of the surface of the bore by the charge pure and simple. Wash is the rush of gas between two surfaces, that is, between projectile and bore, whenever a space is found. Erosion is due to gas moving rapidly at a very high temperature, and, of course, under pressure, although the latter need not be high. Thus, erosion is not found to be serious in the powder chamber, because, although the temperature is high, the gas is not in rapid motion. It is not serious in the forward part of the bore, because, although in rapid motion, the temperature has become considerably reduced. About the seat of the shot and a few calibers beyond it the action is, we repeat it, frightful. Wash can be remedied to a great extent by means of tight-fitting gas-checks, and, as the bore gets enlarged, by augmenting strips of copper. The evil is serious enough, but erosion is the parent of wash, and erosion is the evil to be specially grappled with. It will be found that we use powder of a very different character from other nations, that is, cordite. Surely, matters standing as they do, we ought to put cordite on its trial again, not necessarily as to its behavior in small pieces, but certainly it should be brought up on the charge of wearing out the bores of our heavy guns in an unprecedented manner. If the same thing is going on with our neighbors' powder, we may consider it eventually a necessary evil besetting the use of smokeless powder to obtain very high velocities; but we ought to make sure that this is so before we "sit down" under such a conclusion. We have said that we use very different powder from other nations. Let us see how the matter stands.

We have all adopted powder more or less smokeless, and the foundation of such powder is, we believe, in every case guncotton. This requires an oxidizing agent to consume it completely, and the one that most readily does so is nitroglycerine. Some, however, not unnaturally prefer to avoid the use of nitroglycerine—partly, perhaps, because, unless completely taken up in a stable compound, it is excessively dangerous. This evil, however, appears to have been got over. It has, further, the reputation of causing great erosion. Consequently Russia and the United States have hitherto vetoed it altogether, using nitrate of barium, or other substitute, with guncotton. The result is said to be that their powder is only semi-smokeless, and the products of combustion are not all gaseous, so that there is waste of energy in discharging them. France uses powder of somewhat the same kind. Germany uses, we believe, about 25 per cent. of nitroglycerine. We use cordite containing, according to the official book, 58.3 per cent of nitroglycerine. Before adopting cordite, we subjected it to severe trial, and found that it bore the changes of temperature and exposure to the climatic influences that England, most of all powers, has to contemplate. There is also much to recommend it as to practical convenience. Nevertheless, we think that a *prima facie* case exists for trial in comparison with other powders for charges of heavy guns.

In writing this, we feel that it is quite possible that cordite may turn out to be no worse than its rivals. Sir Andrew Noble, whose opinion should carry more weight than that of any one we could name in this country, has always thought well of cordite, and manufacturers seem to like it. Nevertheless, we would in conclusion repeat the gist of the question as it appears to us. We know that our heavy guns wear so intolerably fast that we cannot reckon on the velocities we assign to them for any considerable number of rounds. We know that their shooting falls off rapidly. We use charges that bear no relation to the strength of our wire guns, at all events in many cases. We know also that other nations will not contemplate cordite, but use powders of widely different character, and do not complain of wear of bore to the same extent as ourselves. We, therefore, think that we ought to test our cordite carefully in comparison with other powders, especially having our heavy guns in view—guns in which, it may be observed, the absence of smoke is of less and less importance as the gun increases in size and its rate of firing becomes less.—*The Engineer.*

THE MARCONI WIRELESS TELEGRAPH INSTALLATION ON BOARD THE NORTH GERMAN LLOYD'S S. S. KAISER WILHELM DER GROSSE.

This, the first merchant steamer to receive a permanent equipment of wireless telegraph, sailed from Bremenhaven February 28, 1900, on her regular trip, touched at Southampton and Cherbourg on the first of March, and arrived at New York on the 7th instant.

The apparatus is almost an exact reproduction of those tested by the bureau last fall on the U. S. S. New York, Massachusetts and Porter, and described in the report of the Marconi board.

The choking coils and cells of the local battery are enclosed in neat wooden boxes.

Various binding posts and fittings are solidly constructed and neatly finished.

The connections to the back-stop of the key for automatically connecting up the receiver are substantially made and are used right along.

The vertical wire is double; *i. e.*, a bight is triced up to the sprit-end and one leg is spliced into the other just before it passes through the top of the deck-house.

An umbrella-shaped sheet of ebonite protects the tube through which the wire is led into this operating-room.

An improved form of cylindrical ebonite insulator is used, having a small strand of seizing wire cemented in each end.

Two substantial wooden posts secured to the forward corners of the deck-house take the strain of the wire which is led midway between them.

No wooden topmast is used, the sprit, about 20 feet long, hoisting to the truck of the steel pole mast, giving an effective height of vertical wire of about 100 feet.

The shore station on the Isle of Borkum, off the mouth of the river Ems, had a vertical wire of 150 feet height.

Messages were received on board the ship 40 miles from this station, and were received at the shore station when the ship was 50 miles away.

An outfit had been sent on board the Borkum Lightship, but owing to the heavy weather the wooden topmast had not yet been secured aloft when the Kaiser Wilhelm passed. This lightship is to have a vertical wire of 130 feet height.

The Marconi operator left the ship at Southampton and is to board her there on her return. In the meantime, an operator in the employ of the steamship company is taking care of the apparatus and learning to operate it.

The first officer of the Kaiser Wilhelm Der Grosse stated that the apparatus had worked without a hitch and communication was not interrupted while the ship was in range of the shore station.

THE DESTROYER BAT.

A serious mishap, fortunately unaccompanied with loss of life, took place on board the torpedo-destroyer Bat on February 21. She was engaged on instructional class duty. The instructional classes have a course of four weeks, the first three weeks consisting of runs at gradually increasing speeds, culminating in one hour's run at top speed. In the case of the Bat, this full-power run was in course of being carried out. Everything was apparently going well, the hour was nearly up, the engines were making 360 revolutions and the boat was travelling at 28 knots. A loud noise was then heard, followed by an escape of steam. Steam was promptly cut off and the eight occupants of the engine-room at the time succeeded in getting on deck without injury. The starboard engine was found to be badly damaged, and the Bat returned to Devonport with the port engine only. On further examination, it is stated that the prime cause can be traced to the cap of the low-pressure crosshead brasses, which fractured across one of the bolt holes. This fracture freed the connecting-rod, which knocked against, and badly bent, the crosshead guide, and made a bulge in the condenser. The piston being also free, was forced up and broke the cylinder cover, at the same time badly cracking the cylinder. It is certainly wonderful, seeing what happened, that no injuries were sustained by any of the men in the engine-room. As it was, there was a rush of steam, which promptness on the part of someone stopped by closing the main steam valve. Had it been in connection with the high-pressure cylinder, one trembles to think what might have happened. We know what took place in connection with the Bullfinch. We understand that an inquiry is to be instituted into the cause of the accident, and we therefore, for the present, refrain from commenting upon it.—*The Engineer*.

A terrible accident, says the *Army and Navy Gazette*, has taken place in the French torpedo-boat No. 228, under command of Lieutenant Pioger. She is a new boat built by the Forges et Chantiers de la Méditerranée, and was under trial at the time. A great part of the programme had been gone through at Cherbourg, a speed of 25½ knots having been attained, and the engineers were full of satisfaction, for the French Admiralty was to give a bounty of 20,000f. for every half-knot above the contract speed. All at once there was a violent shock, and the stokehold and boiler-room were filled with steam. A piston-rod had broken and the cylinder cover had given way. Five men were very seriously scalded and many in lesser degree.

The deepest ocean temperatures which have been recorded were taken by the United States steamer Nero, which is sounding for the cable between Guam and the Midway Islands. At a depth of 30,420 feet the water had a temperature of 35.9 degrees Fahr., and at 9060 feet it was 36 degrees Fahr.

At the present moment the Bat is laid up. Half her consorts are in the same plight, owing to one having broken adrift in a gale and smashed into the others. The Teaser, at Portsmouth, has 6 inches nipped off her bow. The Hunter, which had her bow neatly doubled back some months ago, is still in basin at Portsmouth in that condition. It has, so far, not been deemed worth while to repair her.—*The Engineer.*

In the matter of coaling, the French Admiralty is in marked contrast to our own. Every British ship of size carries a Temperley, but the matter pretty well ends there; there are rarely winches to work them properly, so that the ship is dependent on the collier, and often has to resort to hand-power from lack of means to properly use its Temperleys. This is notably so in the Royal Sovereign class: but the commanders and engineer officers of the Majestic class have vainly asked for extra winches for years. Of course, our principle of always doing a thing by hand-power if possible, is very fine in its way; but like all good things, it can be abused. And in war time every extra minute spent in coaling ships would be important, possibly of deadly moment. Moreover, seeing the strain that watching for torpedo-boats will cause every night, it is imperative that labor when in harbor should be reduced to the absolute minimum. Consequently in peace time everything should be done to facilitate coaling by the most expeditious and least laborious means, for it is very certain that such cannot be extemporized in war time, and the theory that the dockyard people will do the coaling is all theory. They will be far too busy over repairs, nor will there be any spare men at the depots. Yet, despite all this, we proceed in a most casual fashion, and the whip is the real mainstay of coaling.—*The Engineer.*

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A CATECHISM OF COURT-MARTIAL DUTY, published by the Hudson-Kimberly Co., should prove its value and usefulness in simplifying the understanding of responsibilities and duties attendant upon court-martial procedure. The forms of subpœna, conviction, acquittal, etc., are given, and the duties laid down in form of question and answer, so that little previous legal knowledge is needed to understand the method of procedure for the different forms of court-martial.

The book should be of especial value to the officers of the volunteer army.

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A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1901. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

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The prize essay for 1899 was won by Lieut. R. H. Jackson, U. S. N., the title of the prize essay being "Torpedo Craft: their Type and Employment." Lieut. L. H. Chandler, U. S. N., received Honorable Mention for an article entitled "The Automobile Torpedo and its Uses," and was made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of the Board of Control.

R. H. JACKSON,
Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *June 1, 1900.*

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

TORPEDO OPERATIONS IN NAVAL WARFARE.*

THE AUTOMOBILE TORPEDO OF TO-DAY, THE TACTICS AND STRATEGY OF ITS USE, AND THE EFFECT OF ITS INTRODUCTION AFLOAT UPON SEA WARFARE IN GENERAL.

By LIEUTENANT L. H. CHANDLER, U. S. Navy.

Accompanied by Table of Coast Districts and Diagrams as follows:

A.—Section approach, showing dispersion of boats, torpedo fire, and retreat of boats.

B.—Fire of single three-tube boat with adjustable gyroscopes for steering torpedoes, showing retreat of boats.

C.—Fire of single three-tube boat without adjustable gyroscopes for steering torpedoes, showing retreat of boats.

D.—Battleship duel, showing attempt to use torpedoes and ram.

A.—Introductory.

B.—Torpedo vessel warfare pure and simple in coast defense.
  a. Organization of the coast defense flotilla.
  b. The section approach to the enemy.
  c. Torpedo firing tactics of the single torpedo vessel.
  d. The evasion of the enemy's picket or torpedo vessels.

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* Lecture delivered before the U. S. Naval War College, Newport, R. I.

C.—Torpedo vessels with the heavy fleet.
    a. In foreign waters.
    b. In coast defense.
D.—The torpedo aboard vessels other than torpedo vessels.
    a. Limitations upon the weapon imposed by types of tube installation.
    b. Torpedo firing tactics of the single heavy ship.
    c. The use of the torpedo from heavy ships in fleet actions.
E.—Actions between torpedo vessels.
F.—Submarine boats.
G.—Summing up.

A.—INTRODUCTORY.

1. In taking up the subject upon which I have been invited to lecture, I have been met by many difficulties, the greatest of which is the present lack of uniformity of ideas in regard to what constitutes the proper manner of handling the heavy fleet in action. Much thought has been expended on this subject, and one hears many opinions in regard to it, but there is hardly a scheme of fleet action advanced which is not met at once by many very grave objections. Such being the case, it is practically impossible to arrive at any satisfactory conclusions as to the effect of the torpedo upon fleet tactics. It seems to me axiomatic that, under theoretical conditions, with equal fleets and supposedly perfect personnels, every battle or war game must be played to a draw, and that the only way in which one fleet will in future gain a victory over another of equal force is by taking advantage of some error on the part of those in control of the losing force or of some natural, created or accidental conditions which arise. It is therefore very difficult to find any satisfactory chain of reasoning whereby we may follow through a battle in advance, settling upon what one or the other of the adversaries will or will not do at any given point, nor can the effect of the presence or absence of torpedoes from one or both fleets, or of their use or non-use by one or both, be academically laid down in the form of an unanswerable argument. It is possible, however, to set forth the powers of the weapon and to give some of the conditions under which it may be satisfactorily

used, either from heavy ships or from torpedo vessels, and this I will try to do. Given a knowledge of the possibilities and limitations of the torpedo, it is possible for any one to go on imagining and discussing with himself or with others case after case. This is a very amusing and instructive mental exercise, but one which passes quickly beyond the limits of any lecture, and I will therefore leave it, in the main, to those who care to find recreation and professional advancement therein.

2. It is quite possible to lay down a consistent scheme for the use of the torpedo and torpedo vessel in coast defense, and to this point I propose to devote most of my time, believing that to be the great and proper sphere for torpedo action. Within that sphere I am a firm believer in the immense value of the arm.

3. Prior to proceeding to the organization of the flotilla I must ask you to consider a few other preliminary points, and to keep in mind throughout that I speak solely from our own point of view. A number of my arguments, while applicable to ourselves, would fall to the ground were the attempt made to apply them to a foreign service. Thus I consider our torpedo-boat destroyers as little more than torpedo-boats of high sea-keeping capacity and offensive powers. Although able to operate with our heavy fleets somewhat further from our own coast than the torpedo-boats proper can possibly do, the differences between the two classes are of degree and not of kind, and we are so far removed from all possible adversaries (with the exception of the English colonies near at hand and some few nations of military insignificance to the south) that it would be very difficult to conceive of even the destroyers being ordered to accompany our fleet in an expedition against an enemy in his own waters. This was the mistake the Spaniards made, and the almost insurmountable difficulties encountered and the loss of mobility on the part of the big ships which followed showed the folly of the attempt.

4. If it be the case that our destroyers cannot go abroad, so it may also be safely assumed that torpedo vessels of foreign powers need not be looked for upon our own coast, and thus our destroyers, unable to accompany our heavy fleet into waters where their proper prey is to be found, will also not often be called upon to exercise their legitimate powers off our own coast; in other

words, we will probably carry on no offensive torpedo warfare worthy of the name on any hostile shore, nor will we be called upon to resist attacks of that nature at home.

5. I believe that this last statement will receive free and perhaps unfavorable criticism, and I must admit that, like all other rules, it may have its exceptions. At the same time it is hard for me to see the possibility of an enemy's torpedo vessels ever coming to our coast except when that enemy has previously secured control of the ocean, driven our war fleets out of being, and seized upon suitable bases of operations within our own country. When such a preponderance has come into existence against us we will indeed be in serious straits, and the work to be done and the efforts to be made will be of such a desperate nature as to be beyond the limits of sane tactics and to belong among the mad efforts of desperation. So I think it hardly profitable to go into the discussion of such an extreme case at this time.

6. Exception may also be taken that the neighboring English colonies furnish without conquest such bases to our adversary in the case of war with Great Britain. This is true, but in the event of such a war one country or the other will gain the preponderance at sea and our fleets will either operate off and blockade these bases or our own ports will suffer a like closing, the distances being so great even in this case that torpedo vessels would hardly be able to do more than casual duty in front of the enemy's ports. In either event I am of the opinion that neither power would try to carry on any serious operations near the bases of the other until the hostile heavy fleet had been driven out of being, except for the purpose of rendering inactive the enemy's fleet, and in such preliminary operations, where mobility is a prime requisite, I do not believe that the attacking fleet will hamper itself by including torpedo vessels in its numbers. So torpedo vessels would probably not come to our shores while our fleet was in being, nor before a hostile seizure of a base on our coast. In other words, the legitimate duty of the torpedo flotilla is at home breaking up blockades of our ports and not at large on the high seas.

7. While applicable to ourselves, these arguments have little weight in considering hostilities between European powers. Those countries are so near together that destroyers can accompany hostile fleets to an enemy's shores and there show that they are worthy of their name.

8. In preparing my lecture it has been my desire to omit all mention of the mechanical features of the torpedo, but there is one such point which I find I must touch upon here, and also again later in the course of my remarks, and that is the gyroscopic steering gear, the limitations of which seem to me to restrict the operations of the torpedo flotilla at present to our own coast, except under very exceptional circumstances. Without this gear, we all know what the eccentricities of the weapon are; with it properly adjusted the torpedo becomes an instrument of precision which will go where it is pointed quite as accurately as will the projectile from a gun. But, and it is at present a very big but, if the gyroscope is in operation and is not properly adjusted the torpedo will run in a circle and in some cases return to the point of firing, a performance which would be somewhat startling, in a fleet action for instance. In any event, the gyroscope when out of adjustment will render the possibility of a hit non-existent. I consider that the torpedo with the gyroscope adjusted is a very dangerous weapon of precision, that without the gyroscope it is an arm with which success is possible though hardly probable (I would always be glad to make the trial), but that with the gyroscope in action and out of adjustment it is more dangerous to friends than to the enemy.

9. Such being the case, it seems to me that the sphere of usefulness of the torpedo is largely limited by the possibility of keeping the gyroscope in adjustment. These gears can be tested for adjustment either by putting them on the adjusting stand and getting indicator cards from them or by running their torpedoes. The first can only be done on an absolutely horizontal platform free from vibration and from change of original position such as would result from the swinging of a ship about her anchor, and the latter is not a performance to be conducted in the vicinity of the enemy. It would be practically impossible to readjust the gear except on the stand, even though a practice run should show that correction was needed.

10. Therefore we must admit that to get far from base with a torpedo vessel, torpedoes and decks under water in the passage, and then to work successfully, would be a very difficult operation. Until some mechanical genius has succeeded in so arranging the gyroscope that it is a fixture in its gimbals and neither it nor its valve can possibly get out of adjustment, either sepa-

rately or together, and unless it is possible to get ashore or find a smooth harbor and a chance for exercise runs at the end of the passage it would probably be wise to remove the gyroscope after such a sea trip, and take the chances with the torpedo uncontrolled in the horizontal plane, preferring the possible eccentricities of the weapon when guided only by the vertical vanes to the chance of absolute deviation from the set course which would surely result from a badly adjusted gyroscope or valve.

B.—Torpedo Vessel Warfare Pure and Simple in Coast Defense.

a. Organization of the Coast Defense Flotilla.—11. As I have recently set forth my ideas very fully in regard to how the flotilla should be organized for coast defense, I will simply indicate to-day in a general way what I think it should be, referring those who desire to take up the point more fully to the March number of the Proceedings of the Naval Institute, and to the following table of proposed coast districts and of the assignment of vessels to those districts.

12. The nomenclature that I prefer is as follows:

The "flotilla" includes all the torpedo vessels of the navy.

A flotilla "section" is a squadron of seven boats acting together as a unit.

A coast "district" is a section of the coast to which one or more sections are assigned.

A district "base" is the depot and refitting establishment of the district.

13. Briefly, my idea is that our entire coast should be divided into districts, each of which should have assigned to it one or more sections of seven boats each. An advantageous arrangement would be to have one section of boats to each district and one section of destroyers to each pair of adjacent districts. Each district should have a shore base, which, with the sections themselves, should be under the command of the senior officer of the sections, the whole to be free, in time of peace, from the interference of casual senior officers present to a degree equal to the freedom now possessed by vessels of the training service and other special service ships.

14. The boats should be continuously exercised in everything pertaining to their war service, keeping men and material tuned

DIVISION OF SEACOAST OF THE UNITED STATES INTO DISTRICTS FOR DISTRIBUTION OF TORPEDO VESSELS, AS PROPOSED BY LIEUT. L. H. CHANDLER, U. S. N., IN A LECTURE DELIVERED JULY 9, 1900, BEFORE THE U. S. NAVAL WAR COLLEGE, AND IN ESSAY PUBLISHED IN PROCEEDINGS OF THE U. S. NAVAL INSTITUTE FOR MARCH, 1900.

No. of District.	Name of District.	Limit of District.	Base.	No. of Boats.	No. of Dest'rs.
1	Maine	Eastport to Portland	Rockland	7	
2	New Hampshire	Portland to Rockport	Portsmouth	7	7
3	Massachusetts	Gloucester to Provincetown	Boston	7	
4	Rhode Island	Provincetown to Fisher's Island	Newport	7	
5	Long Island Sound	Fisher's Island to New Haven	New London	7	7
6	New York	New Haven to Barnegat	New York	7	
7	Delaware	Barnegat to Winter Quarter Shoal	Near mouth Delaware Bay	7	
8	North Chesapeake	Winter Quarter Shoal to Cape Henry and Chesapeake Bay, north of Thimble Shoal,	Yorktown	7	7
9	South Chesapeake	Cape Charles (Hampton Roads) to Cape Hatteras	Fort Monroe	7	
10	North Carolina	Cape Hatteras to Cape Romain	Wilmington	7	
11	South Carolina	Cape Romain to Port Royal	Charleston	7	7
12	Georgia	Port Royal to St. Mary's Entrance	Savannah	7	
13	Florida	St. Mary's Entrance to Cape Canaveral	Jacksonville	7	
14	Key West	Fowey Rocks to Dry Tortugas	Key West	7	
15	Tampa	Key West to Apalachicola	Tampa	7	7
16	Pensacola	Cape San Blas to Ship Island	Pensacola	7	
17	Mississippi	Ship Island to Atchafalaya Bay	Near mouth Mississippi R.	7	7
18	Galveston	Atchafalaya Bay to Rio Grande	Galveston	7	
19	Porto Rico	Porto Rico	San Juan	7	
20	Cuba	Cuba	Havana	7	
21	Puget Sound	Cape Scott (Vancouver Id.) to Westport (Washington)	Bremerton	7	7
22	Oregon	Westport to Cape Blanco	Astoria	7	
23	North California	Cape Blanco to San Francisco	San Francisco	7	
24	South California	San Francisco to Point Concepçion	San Francisco	7	7
25	San Diego	Point Concepçion to the Rio Tia Juana	San Diego	7	

SUMMARY.	Boats.	Destroyers.
On Atlantic Coast	91	28
On Gulf "	35	14
On Pacific "	35	14
Cuba and Porto Rico	14	....
Total	175	56

Should Cuba be annexed, it would be advisable to have a North Cuba District, base at Havana; and a South Cuba District, base at Santiago. In the future the carrying out of the system here indicated by the formation of districts in the Hawaiian and Philippine Islands would naturally follow, but for the present discussion the division above indicated is sufficient.

up to the highest pitch, while the officers should make themselves familiar with the pilotage of their districts until they can take their boats everywhere under all conditions. Then in case sections are grouped from several districts for special service there will always be competent section leaders, no matter where the concentration may take place.

b. The Section Approach to the Enemy.—15. It is very difficult to do more than theorize in regard to the actual composition and handling of the section, for we have never done any real work of this nature ourselves, and of all the foreign powers possessing flotillas, the only one from which we have been able to learn of the existence of a definite method is Germany, and the system in use in that country, as outlined and modified in this lecture, seems to me to be as good as anything that can be suggested.

16. The section consists of seven boats acting together as a unit, and of course two or more sections could be sationed together or could perhaps be gathered together from neighboring districts when needed for work. In regard to the actual composition of the section, it may be said that the Germans started out with one large boat at the apex of their wedge, with six smaller boats forming the flanks, but they have now changed this arrangement, have given up the smaller boats, and all the units which form the wedge are of the same size or nearly so. I believe the latter scheme to be the best.

17. The best method of attack would be a feint from within the harbor off which the hostile fleet is operating, to be turned into a real attack by other boats from the seaward side. The feint might be made by any type of vessel, whether armed or not, and would naturally draw the pickets, etc., to repel it. Of course, if made by torpedo craft, this feint should be turned into a real attack if circumstances favor. The attack from without should follow the opening of fire by the enemy against the shoreward feint. The perfect attack would be for the harbor section to inaugurate the feint, while one or more sections, possibly of destroyers only, meeting outside and coming from neighboring districts, deliver the real attack. Modifications will suggest themselves as conditions vary.

18. Having noted the general method of attack, we will now consider the actual handling of the section from the time of leaving the base until the attack is terminated. Steaming in a

very sharp wedge, the senior officer in the leading boat, the circumstances of darkness and weather being favorable, at a speed sufficiently low to prevent bursts of fire from the funnels and the rolling up of masses of foam under the bows, the section will follow its leader in pursuit of its prey. The boats must keep as close together as possible, and should be exercised so well that they can preserve their wedge under even the most trying circumstances. In the German Navy, where single-screw boats are much in vogue, it is the boast of the torpedo-boat officers that they can keep this wedge so perfectly that it is possible at all times for a man to pass from one end of the line to the other by stepping from the bow of one boat to the quarter of the one preceding, and those who have seen their maneuvers say that under ordinary circumstances the boast is not an idle one. With twin-screw boats, and I believe those to be the best, this close proximity of bow to quarter would not be practicable, but we should come as near it as possible.

19. The enemy's ship or ships being found, without their having detected the approach of the section, the leading boat will approach the target at low speed, the other boats opening out at higher speeds upon the signal for dispersion until they attain positions on lines radiating from the target at angles of about two points, when they also turn and approach their quarry. The approach would still be at comparatively low speed until discovery, when full speed should be attained at once, and the torpedo fire delivered in the manner to be described later. If the section is discovered prior to or during dispersion it would at once take up full speed and only spread out enough to break up the grouped target before attacking.

20. With a number of boats converging to a common center, and the method of fire hereafter explained, objection may be made that the boats would run a risk of torpedoing each other, and this is true. Still, I believe that with the flat entrance of the torpedo into the water which we have now obtained, where the axis of the torpedo remains in the horizontal plane during launching and the weapon quickly attains and maintains its depth without diving, and with the immersion regulator set for ten feet, that the chance of torpedoing a light-draft vessel would be inconsiderable. In any event, the game is too desperate and the advantages of the method of fire mentioned are too numerous to permit its being modified by this chance of injury to ourselves.

The boats having made the attack as described and delivered their fire, I believe it would be impracticable for them to do more than that. They must retire at once to their shelter, and in my opinion this should be done independently, except that officers should use their best endeavors to aid any friend who may need it. It would be almost impossible to get spare torpedoes into the tubes or to gather the section together after the attack with a view to another effort without first returning to cover, and it would probably not be wise to make more than one sortie in any one night.

21. It will be noted in this connection that a section of seven three-tube boats would get twenty-one torpedoes into the water simultaneously, and it would seem strange if some one of them did not attain its object, provided the attack were in the hands of skilled and daring officers and men. (See Diagram A. In calling your attention to this, the first of the series of diagrams which I have prepared to illustrate this lecture, I wish to admit at the start that I consider this warfare by diagram to be highly unsatisfactory. The most that I have been able to do is to represent in each case a particular condition which might exist on some occasion, not even claiming that it is the most likely situation which might occur. By assuming the most favorable circumstances that I could think of, I have been able to represent certain maneuvers as carried out in what I consider to be the theoretically perfect manner. That they could ever be so carried out in all their details in actual service I have not the slightest idea, but by showing the perfect conditions I have tried to set up ideals toward which our efforts should be constantly directed. Then, by using our best endeavors along the lines laid down, when the moment of trial comes, we can probably attain the best results possible, even though they fall far short of those exhibited in the diagrams.)

c. Torpedo Firing Tactics of the Single Torpedo Vessel.—22. Once more, perforce, I am driven to the mechanical question of the gyroscope, and this time I must give some idea of its powers in order that we may intelligently consider the best methods of using the weapon which it guides. The gyroscopic steering gear, as at present issued to the service, simply ensures a straight run in the direction of the line of fire, keeping the torpedo in the same vertical plane in which it lay at the moment of

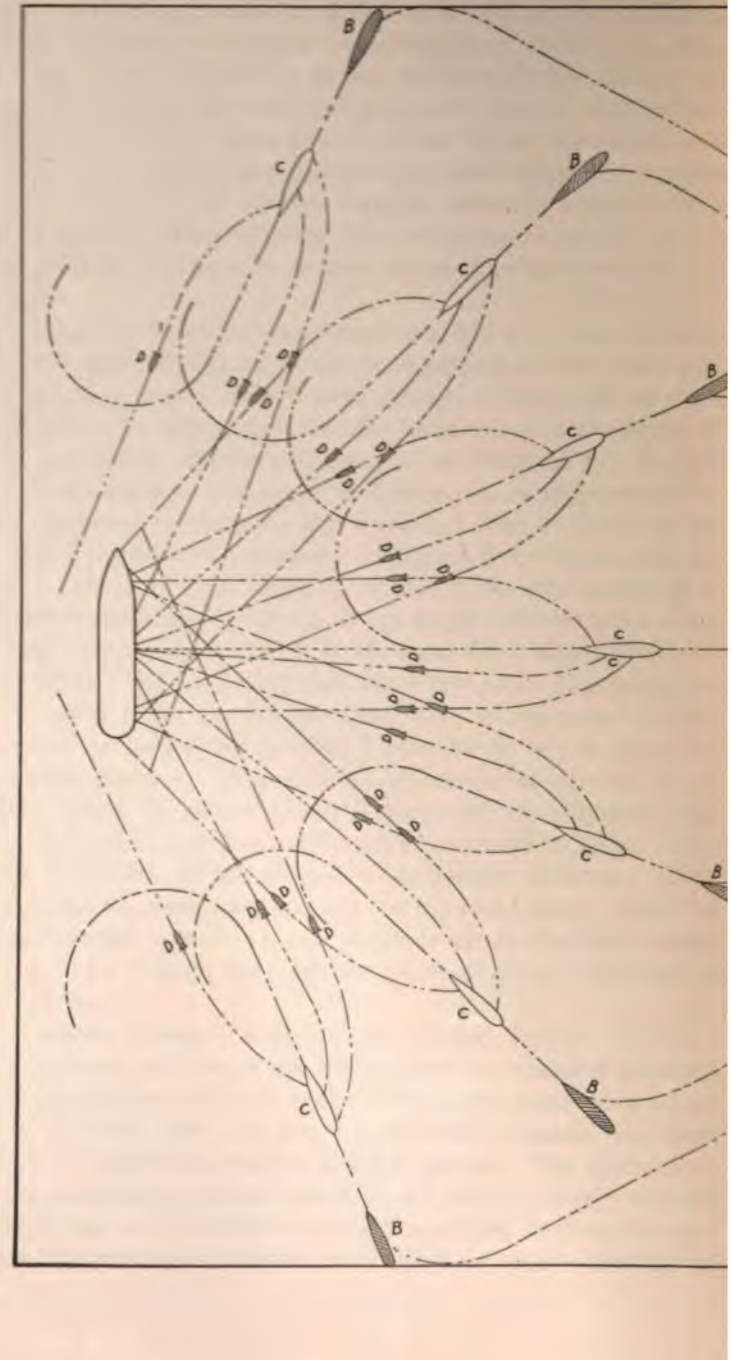
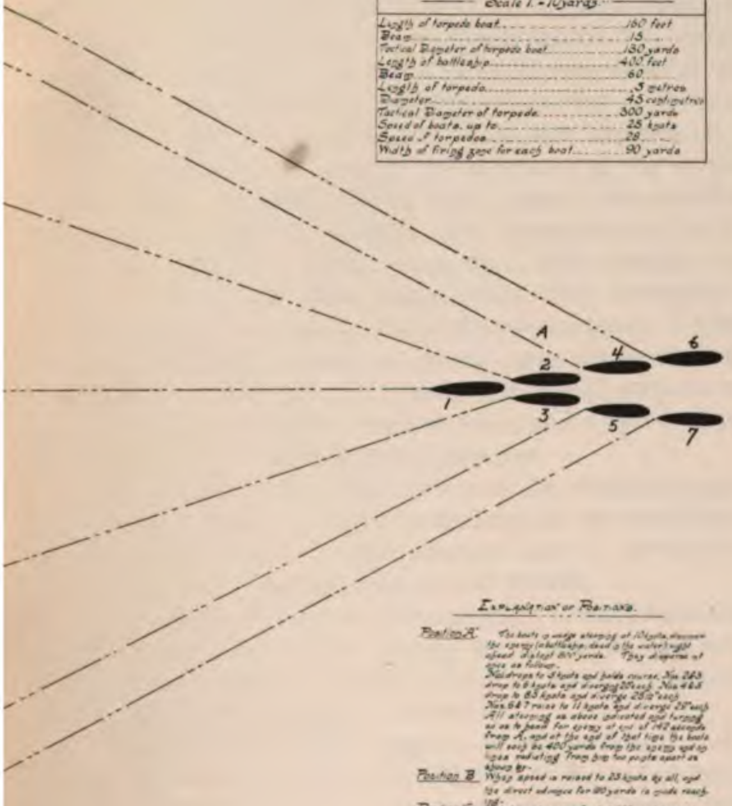

B
C
D

Diagram A.

Section approach, showing dispersion of boats, torpedo fire, and retreat of boats.

To illustrate lecture on Torpedo Warfare, delivered before Naval War College, Newport, R.I., Captain C.H. Stockton, U.S.N. President, Aug. 6. 1900, by Lieut. L.H. Chandler, U.S.N.

General Dimensions. Scale 1" = 10 yards.	
Length of torpedo boat	160 feet
Beam	15 "
Tactical Diameter of torpedo boat	130 yards
Length of battleship	400 feet
Beam	60 "
Length of torpedo	5 metres
Diameter	45 centimetres
Tactical Diameter of torpedo	300 yards
Speed of boats, up to	25 knots
Speed of torpedoes	28 "
Width of firing zone for each boat	90 yards



Explanation of Positions.

Position A. The boats in wedge steaming at 10 knots, discover the enemy (a battleship, dead in the water) right ahead distant 800 yards. They disperse at once as follows. No. 1 drops to 5 knots and holds course. Nos 2 & 3 drop to 8 knots and diverge 20° each. Nos 4 & 5 drop to 8.5 knots and diverge 22½° each. Nos 6 & 7 raise to 11 knots and diverge 25° each. All steering as above indicated and turning so as to head for enemy at end of 142 seconds from A, and at the end of that time the boats will each be 400 yards from the enemy and on lines radiating from him two points apart as shown by —

Position B. When speed is raised to 25 knots by all, and the direct advance for 100 yards is made reaching —

Position C. When torpedoes are fired at 300 yards range. Dropping of speed to 15 knots and sheering off course to allow torpedoes to get ahead, and then turning out to retreat, the boats clear each other and the torpedoes.

Position D. Approximate positions of the torpedoes shortly after firing.

Remarks.

In order to limit the width of the drawing, a target at rest has been selected. For a moving target a similar diagram could be readily constructed, but the dispersing and approach would be upon some point ahead of the battleship such that she would just reach it at the right moment.

ejection from the tube, and eliminating all deflection due to speed and helm action of the firing vessel. With it we have to consider in aiming only the course, speed and distance of the enemy, in other words, we have but to fire the torpedo when its tube points at the spot where the enemy will be when the torpedo has made its run, and this improvement of the weapon which thus simplifies the question of aiming is undoubtedly a very great one. However, this is a very limited application of the gyroscopic principle, for both abroad and at our own Torpedo Station across the harbor gyroscopes are in use which enable the operator to launch the torpedo in one line of fire and then make it take up after entering the water any desired course, that is, within moderate limits, say one hundred and thirty-five degrees on either side of the line of direction of the tube axis at the moment of firing. These adjustable gears have passed the experimental stage and it is only a question of a comparatively short time before they will be in general use, so I shall consider my torpedoes as fitted with these latest gears, only indicating occasional differences due to the use of the present type. I shall also limit my discussion, except in special cases where the contrary is indicated, to the Mark I, 5-meter Whitehead torpedo, with a tactical diameter of three hundred yards and a speed of twenty-eight knots for an eight-hundred-yard run.

23. In treating of the firing tactics of the single torpedo-boat, by which I mean the science of discharging the torpedoes after getting within range, I shall consider only a three-tube boat similar in general arrangement to our Morris.

24. Let us suppose the section approach to have been made as already described, the boats having separated, and that it is now a case of every man for himself. Prior to starting I should have set my tubes and torpedoes as follows:

(*a*) Starboard tube thirty degrees on the starboard bow, with the torpedo set to run thirty-five degrees to the left of the line of fire, or crossing the bow at an angle of five degrees with the keel line of the boat at the instant of firing.

(*b*) Port tube forty-five degrees on the port bow, with the torpedo set to run forty-five degrees to the right of the line of fire, or parallel to the keel of the boat at the instant of firing.

(*c*) Stern tube forty-five degrees on the starboard bow, with the torpedo set to run forty-five degrees to the left of the line of fire, or parallel to the keel of the boat at the instant of firing.

25. With the tubes and torpedoes thus adjusted, the commanding officer would then steer his boat in such a way as to head for the point at which he wishes his torpedoes to arrive, the only allowance that he has to make being for the distance, course and speed of the enemy. Simultaneous fire at the proper moment, electrically controlled by the commanding officer himself, would then give three torpedoes in the water at the same time, running together in a danger zone about ninety yards wide, the two outer torpedoes running parallel to each other and to the keel of the boat at the instant of firing, while the third crosses the belt between the two outer weapons at such an angle as will cause it to cross the middle line of the zone at a distance of about three hundred yards from the point of firing. The increased power of a boat which is fitted for this mode of fire is too evident to require further discussion. Modifications of it for use with boats of other tube arrangement than the standard will readily suggest themselves. (See Diagram B.)

26. With the Obry gear now in use in the service (or without any gyroscope at all, provided the torpedoes will run straight) we could only get a two-tube fire, setting both tubes sharp on the same bow and sheering with the helm just prior to firing in order to bring the tubes to bear, both torpedoes being discharged simultaneously. This method of fire I have used repeatedly aboard the Mackenzie, under most trying conditions of helm and speed, and the Obry gear insured very pretty runs, but the method is inferior to the first given in that it throws the third tube out of action, it requires large helm action of the boat at a most critical time, and the zone of fire is far narrower than in the first method. The two tubes might be trained with a slight divergence, but this would not make the method equal to the first. (See Diagram C.)

27. With the first method of fire the boat would naturally turn toward the side on which the single torpedo was discharged, slowing, if necessary, to avoid collision with the weapon. It is possible that some boats would make a better retreat by reversing and backing out of range, but this is a question that each commanding officer must settle for himself with regard to his own boat. I believe that with a normal boat the helm can be put over either way immediately after firing without danger of running over a torpedo.

d. The Evasion of the Enemy's Picket or Torpedo Vessels.—28. Up to the present moment I have considered only the most

Diagram B

Fire of a single three tube boat, with adjustable gyroscopes for steering torpedoes, showing retreat of boat

To illustrate lecture on Torpedo Warfare delivered before Naval War College, Newport, R. I. Capt C. H. Stockton, U.S.N. President, Aug 6. 1900, by Lieut. L. H. Chandler, U.S.N.

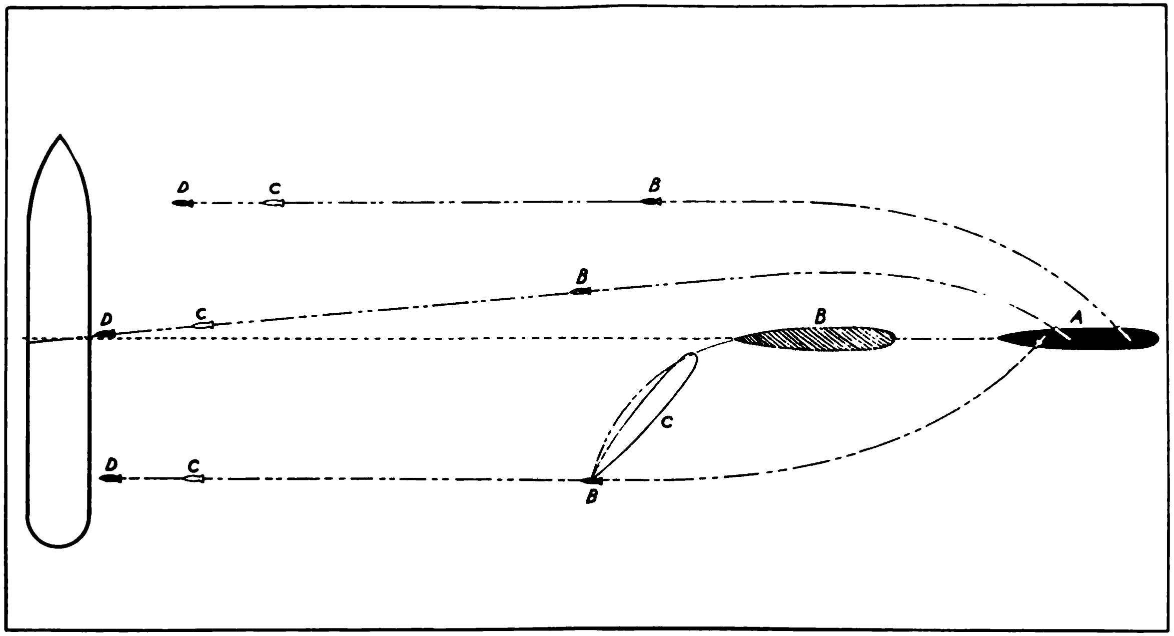
General Dimensions Scale 1" = 5 yards		
Length of torpedo boat	160	feet
Beam of	15	"
Tactical Diameter of torpedo boat	130	yards
Length of battleship	400	feet
Beam of	60	"
Length of torpedo	5	metres
Diameter	.45	cent. metres
Tactical diameter of torpedo	300	yards
Speed of boat, up to	25	knots
Speed of torpedoes	28	"
Width of firing zone	90	yards

Explanation of Positions

Position A.	Boat is in firing position in the act of discharging all torpedoes. She then runs 10 seconds at 15 knots on same course, at the end of which time she and her torpedoes are at—
Position B.	She then turns with starboard helm and crosses track of torpedo from port tube at—
Position C.	The simultaneous positions of the torpedoes are here shown
Position D.	The first torpedo in contact with target

Remarks.

In order to limit the width of the drawing, a target at rest has been selected. For a moving target the boat should be headed from the first, toward the point which the battleship and torpedoes will reach at the same moment.



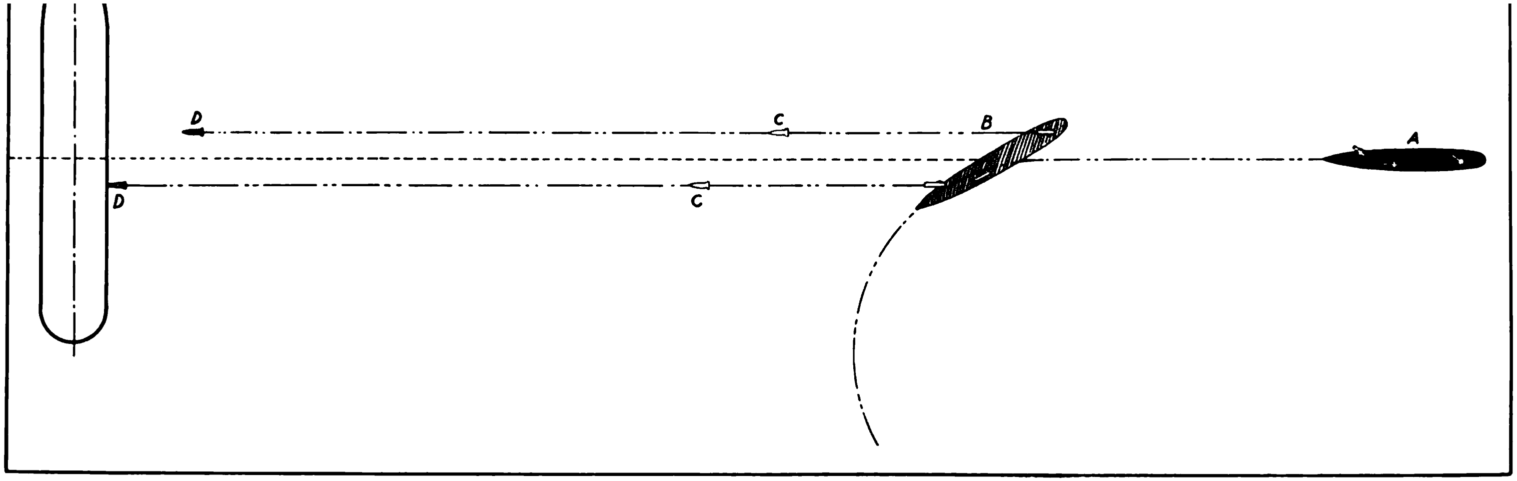


Diagram C.

Fire of a single three tube boat, without adjustable gyroscope for steering torpedoes, showing retreat of boat.

To illustrate lecture on Torpedo Warfare delivered before Naval War College, Newport, R. I. Capt. Charles H. Stockton U.S.N. President, Aug. 6 – 1900.
by Lieut. L. H. Chandler, U.S.N.

General Dimensions.	
Scale 1" = 3 yards.	
Length of torpedo boat	160 feet
Beam	15 .
Tactical Diameter of torpedo boat	130 yards
Length of battleship	400 feet.
Beam	60 .
Length of torpedo	5 Metres
Diameter.	45 Centimetres
Tactical diameter of torpedo	300 Yards
Speed of boat, up to	25 Knots
. . . torpedoes	28 .
Width of firing zone	30 Yards

Remarks.

In order to limit the width of drawing, a target at rest has been selected. For a moving target the boat should be so headed that after her 30° turn her tubes will point at the spot which the torpedoes and the battleship will reach at the same moment.

EXPLANATION OF POSITIONS.

Position A.	Boat at 400 yards from target advancing to attack. Starboard tubes 30° on bow. Port tube not in action. Advances 100 yards at 25 knots and turns to –
Position B.	Where both tubes are fired. The boat continues her turn in retreat.
Position C.	Simultaneous position of torpedoes soon after firing.
Position D	Simultaneous position of torpedoes at moment when first one is in contact with target.

favorable circumstances for the attack, that is where the hostile fleet is on our own coast, and I have not touched upon the question of evading the enemy's picket or torpedo vessels. The case of a fleet which holds itself at some distance from the coast upon which it is operating is also one in which torpedo work is hard to accomplish, but the difficulties are of a similar nature to those already considered, the distance scale being increased to such an extent as to perhaps only allow the destroyers to act. They would have to go further to find their prey, and as the distance is increased the chances of success are greatly diminished.

29. As far as the pickets are concerned, it is probable that the only vessels which an enemy on our coast would have available for this purpose would be such as could be hoisted aboard larger ships. In this case an attack by better sea-boats in fairly heavy weather might be advantageously conducted. In any event, even should the enemy be able to maintain a picket and torpedo vessel line, having a natural or occupied base within a reasonable distance, the defending force should, after a short time, be able to wear out, disable or destroy the small craft outside, so as to render them inoperative, meanwhile repairing its own injuries at its own more convenient base. Such a picket warfare should be carried on for a time prior to the real attack against the heavy ships, until the enemy's small vessels are much reduced in number and efficiency, and in it the effort should be made to inflict the greatest amount of injury possible to the hostile force while receiving as little as possible ourselves; in other words Fabian tactics should be the order of the day. Of course every feint or picket attack should be instantly transformed into the real thing if the opportunity offers itself unexpectedly.

30. It is in relation to the picket vessels that the attack from seaward becomes specially valuable, as by it the enemy is either caught napping or is obliged to halve his picket force in order to guard himself on both sides.

31. When the actual attack on the heavy fleet is made, the pickets must be avoided if possible, but as soon as the section is discovered by them and the alarm given, a partial dispersion followed by an effort to break through at top speed must be made. The small vessels must be disregarded and the effort made to reach the main enemy in spite of them. The force fresh from harbor should be able to attain a much greater speed than

these small patrol craft, and the heavy ships of the enemy, when they open fire, will be just as apt to destroy their own pickets as they will be to repulse the attackers. In any event it becomes a case of do the best you can and trust to chance and a cool head.

32. I may say here that in a recent essay I made the statement that no man has any business to start out on a torpedo attack with any intention of returning. I find that I have been somewhat misunderstood in regard to this point, for I did not mean to say that there was no chance of returning from such an attack. I believe that there is an excellent chance. What I did mean was, not that an attack was necessarily fatal to the participants therein, but that the man who, prior to going out, spends his time in speculating whether or not he will come back, belongs aboard a big ship and not in the torpedo flotilla.

C.—Torpedo Vessels with the Heavy Fleet.

a. In Foreign Waters.—33. In touching upon the relations of the torpedo flotilla to the heavy fleet, I am at a loss to know just what to say in regard to operations in foreign waters, for I do not admit that the boats will never be able to help the fleet when away from home. I merely do not consider that to be their legitimate duty. The locality in each case and the varying conditions which may arise make it almost impossible to deduce anything of value in regard to this point. Where bases can be seized, it may be practicable to have the flotilla aid the fleet abroad, both in opposing hostile ships and in serving as pickets. In treating of defensive boat work I have necessarily set forth the disadvantages under which the offensive boats must labor when on a foreign coast, and I believe that such operations must be considered as special cases in which one must trust to the inspiration of the moment.

34. And in this connection I desire to state that in my opinion we are not giving nearly enough attention to the question of ship's torpedo-boats. I very strongly believe that every vessel large enough to do so should carry one or more torpedo launches, the boats to be so built as not to sacrifice seaworthiness to high speed. A torpedo depot ship, carrying a number of boats, with gear of all sorts and machinery for making repairs, would be an invaluable attendant upon the fleet, while the small boats would earn their cost as pickets alone. My idea of such a boat

is a seaworthy sixty-foot craft with a speed of about ten knots, to carry, say, two one-pounder guns and a single central pivot torpedo-tube for a 3.55 meter torpedo. No air-plant or other special machinery would be installed, for the boats would depend upon the big ships for all mechanical service. A fleet of six battleships and armored cruisers should be able to put a dozen such boats into the water, and the torpedo supply ship should add six more. I am very sure that any fleet commander would be more than glad to feel that at all times he had a flotilla of eighteen such craft at his disposal.

b. In Coast Defense.—35. I believe that there is a very large field for the torpedo vessel in assisting the fleet in coast defense, be it either an offensive or a defensive defense. In the first place there is the opportunity which the torpedo-boat attack pure and simple may lead up to by crippling or destroying some of the hostile ships, thus perhaps turning a superior into an inferior force. Under some circumstances it might be possible to deliver the straight torpedo-boat attack and to follow it up closely by a sortie of the fleet, taking advantage of the inevitable confusion and possible destruction caused by the boats.

36. At another time it might be advisable to have the heavy fleet come out at night and make a dash through the enemy's line, the torpedo-boats following and acting while the enemy is under the almost irresistible temptation to pour all its fire into the big ships just passed but still in sight. The enemy's pickets would here give the alarm, and, after the passage of the heavy fleet, would have laid upon them the duty of breaking up the boat attack, so in passing out the big ships should use their utmost endeavors to destroy every small craft that can be seen, thus freeing the following torpedo-boats as much as possible from the harassments of a running picket fight.

37. It is possible to go on bringing up case after case in which good torpedo work could be done by the flotilla acting with the fleet in offensive coast defense, even including the possibility of hiding the boats behind big ships in a day action until a favorable opportunity for a dash occurs. While it is possible that a chance might occasionally offer itself under these conditions, at the same time I feel that such an effort would be as near madness as it is possible to get. The torpedo-boat is essentially of a nocturnal character, and unless covered by darkness, fog, or some

similar protection, she has very little business within gunshot of the enemy's heavy fleet.

38. The great trouble in actions by a combined fleet of heavy vessels and torpedo-boats is the difficulty of telling friend from foe, especially at night. Even with the plainest identification marks and signals, and with officers and gun pointers thoroughly instructed as to the plan of action, the danger of a mistake is exceedingly great. The chance of destruction by a friend is a risk that every man aboard a torpedo-boat understands and takes, and such a mistake, while much to be deplored, is not necessarily of moment in relation to the great events of the action, but the accidental torpedoing of one's own battleships is much too serious a danger to be willingly undergone without the best of reasons. The need of the moment must decide the amount of such risk that should be taken, and every possible safeguard must be applied.

39. In assisting at a passive defense by fleet and forts, to prevent the forcing of a harbor, the boats would be of the very greatest value, but the topography and hydrography of the individual port to be considered play such an important part in any such engagement that it is useless to attempt to theorize in general terms upon this phase of action.

40. In this connection the question of the use of the automobile torpedo from shore is well worth attention. Although the subject is more properly one for the consideration of our army brothers, I may be forgiven for expressing the opinion that the modern torpedo, which runs accurately up to two thousand yards, with a speed of over twenty knots for that range, is worth something as a part of a shore defense. For this use much larger torpedoes, with increased range, speed and weight of explosive charge could be used, the limits of space, etc., aboard ship being the only reason why it is not possible to secure a higher powered weapon for ship use. Many harbors are narrow at the entrance and so deep as to render mining difficult, as is this very port of Newport, and masked batteries of tubes could well be concealed and effectively used in such cases. It is also probable that in some such cases the Elswick under-water tube, used from submerged chambers, would constitute a very strong element of defense, and one which an enemy would find it exceedingly hard to detect or to combat. It may be noted that such batteries would in no way interfere with friendly shipping.

D.—The Torpedo Aboard Vessels other than Torpedo Vessels.

a. Limitations upon the Weapon Imposed by Types of Tube Installation.—41. Passing from torpedo vessels to the handling of the weapon aboard ships not specially designed for the work, we find that the general policy of the world to-day is to do away with torpedoes aboard big ships except as used from submerged tubes. This I believe to be sound, for I think that opportunities for the use of a torpedo from a big ship will be decidedly rare. At the same time the weapon is one which may give a great advantage at some one instant; its presence aboard ship in a submerged tube does not constitute a special danger to the ship herself as it used to do with the above-water tubes, and the ships of the heavier classes can readily furnish the room for the submerged installation, so I am very strongly in favor of putting that form of tube aboard all heavy ships. With us, in passing from our old policy of putting torpedoes aboard everything afloat to the more sensible scheme outlined above, we have now in service the above-water broadside lower deck tube behind armor in all of our battleships up to the new Maine class. Beginning with the last-named vessel and her sisters, all our new battleships and large armored cruisers will carry at least two submerged tubes, but nothing above water.

42. The lower deck broadside tube, as generally installed on our ships, is pivoted to the side and has a train of fifty to sixty degrees on each side of the beam, which, with the adjustable gyroscope, gives a very considerable range of fire, especially with the ships that have two such tubes on each side. As there is a very strong tendency to do away with even this form of above-water tube, and as the method of fire from big ships will be practically the same with either the submerged or the lower deck tube except that four above-water tubes will give more chance of hitting than two fixed submerged tubes, I shall consider only a vessel of the new Maine class, having two submerged tubes, one fixed on each beam at a point forward of the dead flat section.

43. The submerged tube, as already stated, is a fixture in the ship, and is not capable of being trained. It may be placed to point in almost any direction relative to the fore and aft line, but the custom is to place it either normal to the ship's side or else to point abeam. The latter installation has been adopted in our

service. Such being the case, the only variation from beam fire that we can get is by the use of the adjustable gyroscope, which will enable us to run torpedoes from these tubes parallel to the keel in either direction, or even to a certain degree across the bow or stern.

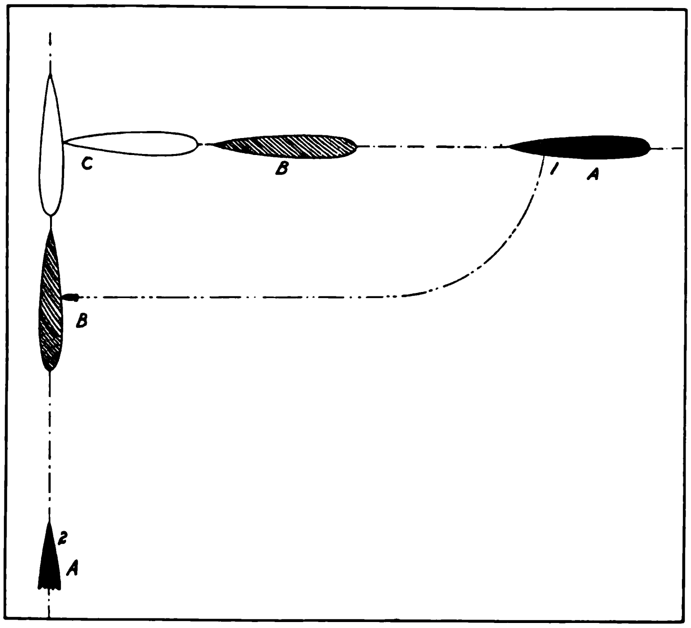
b. Torpedo Firing Tactics of the Single Heavy Ship.—44. As the torpedo and the ram are both weapons which require that the ships shall close with each other before they can be used, it seems to me that the two go together, and that a captain would hardly ever close for the use of one without expecting to try to use the other also. When we consider this maneuver we will find the conditions somewhat different from those we have already examined in connection with torpedo vessels, for with these last named the object is to so direct your course and speed that the enemy's path and your own will intersect, but the enemy and your own vessel must not reach the intersection at the same moment. The torpedo-boat must be some distance from the point of crossing, her object being to have her torpedoes and not her own hull at that point when the hostile ship reaches it. With a big ship it is different, in that the attacking vessel desires to have her ram reach the intersection simultaneously with the enemy's beam. Such being the case, the enemy must be torpedoed before the courses cross, and the question is as to how best to coordinate the ram with the two torpedoes in tubes pointed one on each beam. To get the best chance for using each one of these three weapons, I believe both torpedoes should be set to run ahead parallel to the keel. With a torpedo tactical diameter of three hundred yards this would bring each of them into a path parallel to the course of the ship but one hundred and fifty yards away from her, each on its own side. For example, let us consider two ships steering courses at right angles to each other and approaching at equal speeds an intersection equidistant from both, as shown in Diagram D. If when at *A*, 431 yards from the intersection, No. 1 fires her port torpedo with the gyroscope set as described above, being 610 yards from No. 2 at the moment, the torpedo will describe a track 517 yards long, and will arrive at *B*, one hundred and fifty yards from the intersection, simultaneously with the center of No. 2, both vessels moving at 15 knots, and a hit will be secured. Failing of its effect for any reason, the ships would approach each other at

Diagram D.

Battleship duel, showing attempt to use torpedoes and ram.

To illustrate lecture on Torpedo Warfare before
Naval War College, Newport, R. I. Captain C. H. Stockton
U.S.N. President, Aug 6. 1900. by Lieut. L. H. Chandler U.S.N.

General Dimensions.	
Scale 1" = 15 yards.	
Length of each ship	400 feet
Beam	60 "
Speed	15 knots
Distance of tube from bow	90 feet
Length of torpedo	5 metres
Tactical radius of torpedo	150 yards
Speed of torpedo on straight course	28 knots
" " " " arc of "	27 "
Distance between Nos 1 & 2 in position "A"	610 yards



Explanation of Positions

Position A Ships steering courses at right angles to each other and at equal distances from the point of intersection of their courses, both steaming at 15 knots. No 1 desires to torpedo and ram No 2. At A distant 431½ yards from intersection, No 1 fires her port torpedo as shown.

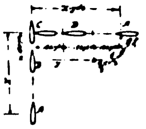
The torpedo runs 236 yards on the arc of a circle and 281½ yards on a straight course, reaching its target as shown when both ships and the torpedo are at —

Position B Should this torpedo miss the target, the ships continue to close, traveling 150 yards before coming together at—

Position C where No 1 rams No 2.

If the ram stroke failed, due to the fact that No 1 was late in arriving at the intersection of course, the officer at the torpedo director of the starboard tube of No 1, would see No 2 drawing across his bow and would at once fire his torpedo, with a good show of hitting No 2 after she had escaped the ram.

It will be noted that in Position A, No 2 has the same opportunity for using a torpedo as No 1 and also if No 2 escapes across the bow of No 1, her port torpedo set to run astern would be effective against No 1 after she had crossed astern of her adversary.



Speed of ships = 15 knots an hour = 8.4 yds a second
" " torpedo on arc = 27 knots an hour = 15.2 yds. "
" " " straight = 28 " " " = 15.7 " "

and y = x − 150

Therefore [illegible] = time taken by torpedo to run and [illegible] = time taken by target to run from A to B hence [illegible]

Whence x = [illegible] yards
y = [illegible]

And distance from No 1 to No 2 at A, the firing position is 610 yards

Now if No 1 fires at A, when x = 431.5 yards, then the torpedo will run 236 + 281.5 yards which will take it [illegible] = 33.4 seconds

Also if No 2 were at A when No 1 fires her torpedo, then she would run to B, the point of intersection of her course with that of the torpedo, in [illegible] = 33.4 seconds and the target and torpedo would then arrive at the same point at the same instant and a hit would be scored

equal speeds as shown, until No. 1 has her chance with the ram at *C*. Of course the captain of the ramming ship would exercise the greatest caution to keep from missing his ram stroke in such a way as to cross his enemy's bow, and is more apt to get to the point of intersection too late than too early.

Under the conditions shown, the officer in charge of the starboard tube would be at his station, and the instant he saw the adversary coming across the bow in such a way as to indicate that the effort to ram was a failure, he would at once fire his torpedo, thus having a chance at the escaping enemy just after he had crossed the bow. By this method of fire we first try with one torpedo; if that fails we get a chance with the ram, and failing with that we have a third opportunity with the other torpedo. With two tubes on each side the forward torpedo on each side should be set to run ahead parallel to the keel and the after one to diverge five degrees away from it, thus giving by simultaneous fire a much greater chance of hitting than with only one weapon. If the attack fails totally the ship would keep on her way at high speed without altering her helm, running down the lane between her torpedoes until they stop and sink, thus getting away from her adversary's probable effort to counter and keeping clear of her own torpedoes at the same time. It may be pointed out that this chance of torpedo fire is equally open to No. 2 when at *A*, and also after she passes No. 1, if she does so. Also in every such action it requires but a slight miscalculation or change in conditions to convert attacker to attacked and vice versa, and that as a maneuver it is an essentially dangerous one, one that should only be attempted under exceptional circumstances.

45. To those who claim that her own torpedoes would constitute a danger to the ship firing them, I reply that ram and torpedo work is the very essence of all that is dangerous. It is staking all upon a single throw, and if a captain has allowed his torpedo officer proper opportunities to become acquainted with the individual mechanisms under his charge, then the chance of a torpedo failure dangerous to the attacker is not too great to be taken with a light heart, provided the circumstances warrant incurring the dangers from the enemy already pointed out.

46. In this form of attack the analogy between the tactics of the torpedo vessel and of the battleship is very plain. The latter

has for the moment transformed herself into a torpedo-boat with guns and ram added, trusting to her gun fire and brutal ability to stand punishment to give her that protection which the frailer vessel seeks under the friendly cover of night or fog.

47. The only case in which I can conceive that a heavy ship would use her torpedoes in defense is when attacked by one or more heavy vessels that she cannot keep off by her gun fire. It is more than likely that her motive and maneuvering powers would be disabled before these conditions arose. In going into a fight I should always prepare to use the torpedoes with the ram in the offensive, and so should have them set for ahead-fire as described above. As in making such an attack one would naturally try to approach an enemy's beam, so we may expect that the torpedo would be mainly used in defense against a target abeam or nearly so. Thus we would have to reset the torpedo steering gear before making such use of it, and the ability to get this done in time will depend not only upon the efficiency of the torpedo handlers, but also very largely upon the facility with which orders can be passed between conning-tower, torpedo-firing stations and manipulating room.

48. In this connection it may be said that it is essential that proper firing stations be established aboard these ships. The English practice is to fire from the conning-tower, but to me it seems manifest that the captain cannot reasonably be expected to manipulate torpedo directors and attend to other torpedo details in the already too crowded conning-tower, and therefore we must establish armored stations to keep off the heavy rapid fire at close range which will of necessity be endured while closing to torpedo range or while being closed upon. Every possible facility of communication between the conning-tower, firing stations and manipulating rooms must be supplied, and the officer at the director must himself fire the torpedo electrically without any intermediary. While hitherto neglected, this point has been covered in the Maine class after a fashion, at least the arrangement there is better than the absence of any system at all under which we have hitherto labored. This question is a difficult one to solve satisfactorily, and is well worthy of more thought than has yet been bestowed upon it.

49. In my judgment the effort to torpedo a ship which is approaching bows on, or nearly so, to ram, is going to be very diffi-

cult to bring to a successful conclusion. The target presented is very small, and the angle at which the torpedo will strike, even if a hit is secured, will necessarily be so oblique as to render a failure of the exploder more than likely, while the bow wave of the onrushing ship would tend to throw the torpedo bodily to one side, or to deflect it momentarily to a still more oblique impact before the gyroscope could take charge and return it to its course. I therefore believe that the much exploited use of the torpedo to keep off a ramming enemy when disabled is more likely to prove a failure than a success. In other words, the torpedo appears again as the weapon of an active attacker, rather than one for passive defense. Even to take advantage of it when cornered by a superior force, the ship using it must for the moment make a vicious attack if she would hope to accomplish her object. If for special reasons it be desired to ram an enemy whose helm or engines are injured, I do not consider that the risk of being torpedoed in so doing is too great to be taken, but if time served in all probability it would be better to lay off and choose angle and distance, letting the guns do the work in comparative safety.

50. A vessel attempting to torpedo and ram an adversary and failing will find herself in great danger from torpedoes if she passes astern of her adversary, and from both ram and torpedoes should she arrive at the intersection of courses too soon, and here again it is very necessary for the commanding officer of the attacked vessel to be able to quickly communicate changes of plan to the torpedo personnel, in order that gyroscopes may be reset if desired. A vessel passing either ahead or astern of another at close range is peculiarly liable to a blow from a torpedo, for with a ninety degree change of course by the torpedo after firing we get a beam impact with every chance of success, provided we are only quick enough to take advantage of it.

51. The different possibilities for attack and defense arising in this manner are numberless, and much can be learned from a consideration of individual cases, but I will pursue the question no further at this time.

c. The Use of the Torpedo from Heavy Ships in Fleet Actions.—52. As we pass from the tactics of the single ship to the use of the torpedo from big ships in fleet actions, I must confess that the question becomes so large as to render a satisfactory discussion well nigh impossible, including, as it does, the entire question of the battle tactics of the heavy fleet. Consider two modern fleets opposed, of equal power and with equal personnels, and, as has already been said, the game will, from a checker-board point of view, always be played to a draw, but on the high seas, with men of different abilities in control, there will most probably be some sort of preliminary fencing, which I feel sure will be in column or some similar formation. Judging from the lessons of the past, the object will be to take advantage of some favorable circumstances, natural, accidental or created, to so double your own entire force on some fraction of the hostile fleet as to enable you to overwhelm part of his ships with less loss to yourself before the rest of the opposing fleet can get into action. As in the past, this will probably result in an effort to concentrate on the actual rear, but with the present range of guns and mobility of ships it will be very hard to accomplish unless there be some great error on the part of one of the fleet commanders or his subordinates. I believe that, barring accidents, this is the only way in which a decisive action between equal fleets can be pulled off, and as its conduct depends very largely upon failure upon the part of certain men in some unforeseen direction, it is useless to try to lay out any plan for taking advantage of such errors.

53. This much may be said, however, that as the effort will probably be to break through the enemy's line and cut off some of his ships, torpedoes should be set for use ahead as previously described, the weapon appearing in the offensive again, being used in breaking through the line. The point at once appears again, that a vessel approaching bows on is in excellent shape to use her torpedoes, while she presents the most difficult target possible to her adversary.

E.—Actions Between Torpedo Vessels.

54. I can conceive of no circumstances under which two groups of torpedo vessels will ever engage each other as do big ships in fleets. To my mind torpedo-boat actions will consist of running fights between two groups, one of which is endeavoring to seek shelter under friendly heavy batteries from an attacking force of boats or destroyers. In other words, it will always be a bow and stern fight, and I believe that in all torpedo vessels the right-ahead and right-astern gun fire should be exalted at the expense

of the beam fire. Being a case of chase, I believe that there will be but little tactics in it. Boats must not be so far advanced from support as to allow themselves to be cut off, but beyond that I can see no other rules to be laid down. If chased by a heavy ship the stern fire would also be of value, and a torpedo fire astern similar to that described for attack ahead would prove very discouraging to the pursuer.

F.—SUBMARINE BOATS.

55. In regard to submarine boats, I may say that Mr. Holland has given us a very good boat as far as it goes. However, in spite of claims to the contrary, no decent speed can be attained nor can the crew remain aboard more than a few hours, and it is no more possible to see under water than it used to be. Here we have serious limitations which yet remain to be overcome. Meanwhile, I believe that the boat is as good as any in use abroad, that she is comparatively safe for her crew, and that there are very considerable possibilities in the type. Certainly the moral effect upon a blockading fleet would be very great, and I believe that once in a while one of the boats would accomplish something. I think that the question of tactics in regard to these craft is hardly yet ripe for discussion.

G.—SUMMING UP.

56. In summing up I will state in a few words what I think has probably become apparent in the course of my lecture, that within the limits I have laid down I am enthusiastic as to the possibilities of torpedo warfare. Beyond those limits I should always be willing and anxious to try it, under almost any circumstances, but I should consider failure rather more apt to follow the effort than success.

57. I believe no officer will ever do anything with the torpedo who waits for his enemy to come within reach. There is but one way to use the weapon, even in the defensive, and that is to go in search of your adversary and deliver upon him the most vicious attack that you can possibly contrive. Then, if the officers and men who have the matter in hand have the requisite skill, experience and nerve for handling so delicate a weapon, and if time and conditions be well chosen, the action will take place with the greatest possible chances of success.

58. In closing I may say that I make no claim to having covered the entire subject, for I believe it to be an inexhaustible one. I have merely pointed out what I consider to be the most favorable circumstances for the use of the torpedo and the best means of taking advantage of them, with a few words as to the possibilities of using the weapon under less advantageous circumstances. If in so doing I shall cause or help others to consider the subject more fully and to give the service the benefit of their thoughts, I shall feel that I have accomplished an end of much value and shall be more than repaid for my labor.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MEMORANDUM ON GENERAL STAFF FOR THE U. S. NAVY.

By CAPTAIN H. C. TAYLOR, U. S. Navy.

INTRODUCTION.

The following memorandum was submitted to the Navy Department last winter. The general idea it embodied met with approval, and one of its immediate consequences has been the establishment of a Board to undertake General Staff work. The Board is known as the "General Board."

The Department has permitted the ideas contained in this memorandum to be made public, and as some officers have formed mistaken notions of the duties which the General Board is to perform it seems desirable that the original memorandum should appear in the Naval Institute. The suggestions contained at the close of the memorandum were not regarded as final, but were only to serve as a basis for discussion. Some of the suggestions were approved, others were not, and still others were approved but could not at the moment be carried out, owing to a scarcity of officers, or other causes.

The value of the memorandum will be in rendering practical the principle, hitherto vaguely expressed, of a General Staff, the first stage having been reached when the Office of Intelligence and the War College became firmly established. The creation of a General Staff for the navy of a great nation must be like all large movements, of slow growth. Any undue suddenness or jerkiness tends to dissipate the strength of the onward impulse. The Germans took fifty years to perfect their General Staff; we will not probably achieve it in less than twenty-five years. How much of that time we may already have gained in the last fifteen years of the Intelligence Office and the War College, we cannot accurately compute. But in any case we have some years yet of earnest work before we can enjoy the benefits in our Navy, which the German Army only began to reap after 1860.

The reactionary element in the Navy will have its effect upon this development, and for that reason it is not certain that the form the General Staff movement now takes will be permanent. This form is the establishment of a General Board having for a nucleus the War College and the Intelligence Office, combined under the Chief of Navigation. Other methods may be from time to time substituted for these if found desirable, but it is hoped that whatever be the means employed, the end to be attained as shown in the memorandum will be kept constantly in view by the Navy, in order that as our fleet expands to large proportions, its proper disposition in war may be provided for.

MEMORANDUM.

The need for a General Staff in our Navy is not unnatural: All military organizations, afloat and ashore, experience the same necessity, as do all large business enterprises in civil life, though under other names than that of General Staff. The regular traffic of a railroad ten miles long, connecting two unimportant villages needs only honest management and some technical skill; but when such a railroad, having grown to thousands of miles of track and drawing its freights from far distant territory, is forced to consider the varying conditions of agriculture, manufacture and navigation upon which its own life is based, it is no longer enough for it to possess skilled engineers and accountants, but there must be a group of men who have, as their principal work, to *think* for the railroad, to observe rival lines, to consider the local laws of towns and states which their tracks traverse, and above all, to *watch the future* and prepare their system to draw all possible advantage from events—agricultural, financial and political—as they occur.

These duties, usually performed by Boards of Directors or central committees of management, are similar to those which, in a military force on land or sea, are performed by a general staff, whether called by that name or not.

The functions of such a group of officers are developed usually by the continuance of wars through considerable periods, although there are exceptions, one of which—and the most notable for effectiveness—being the General Staff of the German Army, which attained its excellent efficiency through the half century succeeding the Napoleonic wars, a period of almost unbroken peace in Europe.

It is probably more accurate to say that the necessity for a General Staff is developed and made apparent by long wars, while the proper evolution of its duties and the thorough training of its members is more successfully accomplished during times of peace. Herein, however, lies a danger. The tendency of military bodies in peace is to grow theoretical and unpractical, and the utmost care is needed to combat this mental drift of intelligent officers who study war methods, which a long peace prevents their actively practicing. General Von Clausewitz, himself a veteran Chief of Staff, cautions armies against giving up certain field duties to the General Staff, saying that the higher officers of that corps gain thus an undue mental predominance that leads to an exclusiveness fatal to efficiency. Dispositions of forces, he adds, that should be made without previous bias of mind and to suit each case as it arises on the field, are adopted as the outcome of a rigid, narrow plan decided upon beforehand in office or camp.

It is probably with this caution in mind that the Germans have arranged that officers of the General Staff shall alternate their service on the staff with periods of active regimental work in field or garrison. Thus they avoid during peace that condition of "theory gone mad," which some other armies have finally corrected only after serious disasters in war.

The Franco-Prussian conflict of 1870 plainly indicated the value of the German General Staff; and the armies of the great powers, except perhaps the United States and England, have endeavored, with varying success, to imitate it.

With navies it has not been regarded as so essential, many naval officers of all nations having failed to perceive that the underlying principles of a military force are the same afloat as ashore. It is to be noted, however, that the Board of Admiralty in England satisfies many of the conditions of a General Staff, at the same time that it controls the material construction and manning of the fleet.

Let us now consider what are the real functions of the General Staff of an army or a navy.

Its duties, as generally understood, are to gather information concerning foreign navies or armies, and to measure and correctly appreciate their military value; to consider the probable aims and purposes of those foreign services in case of war; to gain a knowledge of their strong places and of the strategic centers they are likely to occupy at the opening of hostilities; the relation of their force and its strategic center of action to our territory and force in its probable area of action; finally, a careful comparison of our own strength with that of other nations.

Based upon the above examinations, plans are made for the various warlike contingencies likely to occur. These plans are based, primarily, upon strategic and tactical principles, and later, worked out with a detail that grows more minute as information increases and deliberations mature. These plans which, in the Navy, concern themselves at first with our regular force of battleships and auxiliaries, will gradually include Naval Militia and Reserves, merchant vessels, the naval defense of anchorages unprotected by the army, the provision of additional men for emergencies, and finally, after frequent consultations with the army chiefs, they will provide for that exact cooperation of the army and navy so important to success.

It will often occur that the Secretary of the Navy, when these war plans are before him, will find certain changes expedient in the peace policy and establishment, as natural deductions from the war preparations, and one effect of this work will be to recognize that the Navy is a war machine with incidental purposes of peace. When this principle is acted upon, the Navy will become both economical and efficient.

The above making of plans is the first element of General Staff work, and is generally, though vaguely, recognized as being its proper duty.

The second element, though rarely recognized in a formal manner, is by far the more important of the two. It is the mental training of officers engaged in this plan-making, and their consequent readiness to confront warlike situations in general. It does not equal the school of actual war, but it is only second to it—and there is no third method. This trained readiness of officers' minds, in the Franco-Prussian War of 1870, constituted the essential value of the diligent staff work done by the Germans during fifty years of peace. What the world at large saw were the plans of work perfected in all minutiae, railroad cars numbered for special work, arriving near battlefields on schedule time, bringing guns or men, pontoons or hospital beds. This it was which, being so admired, gave to the Staff its reputation among nonprofessional people, and it was, in fact, a most valuable aid in the battle and campaign; but far greater, as a factor of efficiency, was the state of mind of German officers—from Generals down to Majors—that familiarity with war situations, acquired in the staff work of peace, which enabled them to confront all emergencies of the campaign with ready energy and composure of mind.

Such, then, are the purposes of a General Staff. The American Navy has for some years felt instinctively that this, or something like this, was needed for future efficiency. Evidence of this is apparent in the creation, many years ago, of a War College at Newport and an Office of Intelligence in the Navy Department. In those two institutions are to be found many of the elements of a General Staff, requiring only a slight drawing together by a common head—such as the Assistant Secretary or the Chief of Navigation—to create a nucleus of effort around which would form a body of great usefulness to the Navy and the country. It would grow of itself, needing but one care and precaution on the part of the Navy, namely that of selecting always for that duty officers best known for their practical success in the handling of ships and command of men, and forbidding any continuous staff duty, in order that frequent tours of active service afloat, alternating with the General Staff work ashore, may prevent that over-theorizing in which exists always the initial germ of decay for any practical calling, and especially for a profession of arms.

In the development of the Intelligence Office and War College the Navy has been unconsciously forming the elements of a General Staff, until now the time has arrived when, much of the work having been done, the Navy can decide whether it shall give life to these elements, by providing a concert of action for them, by adding to them such minor work as may be fitting, and by assigning the whole to the charge of some official, such as the Assistant Secretary or the Chief of Bureau of Navigation, who, by the nature of his present duties, is already prepared for their superintendence.

The representative form of our government causes a tendency in the executive branch to lean somewhat upon Congress and to ask its action, before any decided movement or change is undertaken in any of the Departments. This tendency, proper in all representative governments up to a certain point, has at times been carried too far, and projects still crude and requiring years of trial and examination by the executive, have been placed before Congress with requests for legislation, which have resulted in measures not always satisfactory in their operation to the very persons who have asked for them.

This evil is not a necessary one. The scope of the executive power is quite sufficient to permit such testing of new methods as may be needed to convince us of their efficiency, before submitting them to Congress. In the case of a long-established military service such as the American Navy, the creating of a General Staff should be a gradual evolution, carried on under the eye of the Department and continued until, when satisfied with the result, the Department asks Congress to pass a measure which solidifies into law, and sanctions the continuance of a condition of things already in fact existing.

Up to the point where the money is needed and the legislative function is thus encountered, there seems to be no reason why the Navy Department should not develop a system of General Staff in the Navy, though it need not have that title. Later on, when some years of trial, change and modification shall have perfected the system, the formal sanction of Congress can be asked, and such moneys appropriated as may then be needed for its maintenance.

It appears from the annual report of the Secretary of War for

1899, that he has in view a General Staff for the army, under the name and form of a War College, and the ideas embodied in that report being sound and practical, there seems no question that, with certain modifications, they will gradually establish themselves as the foundation of a military structure worthy of the learning and gallantry of the army officers. The movement will, perforce, be slow in armies or navies, being obstructed continually by those tendencies to stagnation which lie hidden under the disguise of "military traditions."

From the naval point of view, this project of the army's is an excellent one. A more definite embodiment of the Military Intelligence Office in their work seems to us desirable, and it is very expedient to insure the students of the War College being principally of and above the grade of Major, leaving the schools of application at Monroe, Leavenworth, Reilly and Willets Point to engage the attention of the more junior grades. Experience will doubtless instruct the army officers to make any such changes as may prove desirable.

This memorandum has been written in reply to an inquiry from the Secretary of the Navy as to what concrete things should be done at present in the development of a General Staff.

If, in response to this inquiry, we should submit a complete plan covering many years, elaborate in detail and precise as to dates, we would by this only indicate our own ignorance of the true nature of the project; but we may with confidence suggest some measures whose necessity is now plainly apparent. At present, we perceive certain things: 1st, that we have established a War College and Office of Intelligence; 2nd, that these two are essential elements of a General Staff; 3rd, that the Department appointed a War Board when the late war began, indicating by such action the need of General Staff advice. Let us base present action upon these facts with the following suggestions:

a. The Secretary to issue an order to the War College and Office of Naval Intelligence that their work shall be regarded as directly connected and interdependent, and that the chiefs of the two institutions and their first assistants and the Chief of Bureau of Navigation shall constitute a permanent board of five members, who shall meet frequently and consult as to war plans and information. That one-half the Intelligence Office force shall pass four months of each year at the War College, and one-half the War College force four months at the Intelligence Office.

b. An order to the Chief of Bureau of Navigation and others concerned, that their Board of five shall meet, in November of each year, the Senior Officer of the Navy and the officer commanding the North Atlantic Fleet and their Chiefs of Staff, and this board of nine shall consider the war plans and other data that have been devised and arranged during the twelve months preceding; and this board may be convened at other times, in addition to the November session, when thought desirable.

c. That the approved plans be in the custody of the Chief of Bureau of Navigation; that the combined work of the College and Intelligence Office be under the general direction and orders of the Chief of Bureau of Navigation; and that the Secretary receive, through him, the war plans as completed, and such suggestions as to the fleet and its disposition as may from time to time result from the discussion of the plans.

d. When matters of constructing, arming, equipping or manning the fleet are necessarily deduced from the War Plans, and require action of the Department and its Bureaus in supplying ships and their accessories, they shall be submitted to the Assistant Secretary, who shall consider them and transmit them to the Secretary of the Navy.

e. A Department Order that the staff of the Intelligence Office be not less than ten officers, of whom one-half be above the grade of Lieutenant, Junior Grade; and the permanent staff of the War College be not less than eight officers, of whom one-half be above the grade of Lieutenant.

That the number of officers taking the course at the War College each year be not less than thirty, of whom ten may be, when desired, of the Marine Corps, Army, Revenue, and Naval Reserve or Militia services. Of the officers of the Navy, three-fourths must be above the grade of Lieutenant.

At the close of the course, the names of those desirable for future work in the War College or Intelligence Office will be submitted to the Chief of Bureau of Navigation, in his capacity as Chief of General Staff, and will be chosen for this work whenever sea duty permits.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

AN ADDRESS DELIVERED BEFORE THE NAVAL WAR COLLEGE, NEWPORT, R. I.*

By The Hon. Frank W. Hackett, Asst. Sec. of the Navy.

Mr. President and Gentlemen of the War College:

The twelvemonth just past has proved a busy year in national affairs. For the first time since the formation of the Government has it fallen to the President to send from our shores to an island of the sea a civil governor, who should in his person represent the dignity and power of the United States. Fortunately for us, and fortunately for Porto Rico, the Chief Executive was at no loss whither to turn.

A judgment so sound, and an address so pleasing, had characterized the administration of Assistant Secretary Allen that the President bade him lay aside his work for the Navy, and hasten to San Juan with a message of good will.

You who have witnessed the success attendant upon his efforts for the welfare of the service need not be reminded how completely to Mr. Allen's taste was the work in which he had become engrossed. You may well understand with what reluctance he has abandoned these congenial duties in order to take up larger responsibilities in an unfamiliar field. The new Governor yielded to the choice of the President from a dictate of duty. He was sorry to leave the Department, and everybody there was sorry to part from him.

Let us rejoice, however, that the people of Porto Rico are setting out upon their new political life under the guidance of so gallant a leader.

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* At the annual opening, June 2, 1900.

Standing here as the successor of Assistant Secretary Allen, I share your regret that to-day does not find him here speaking to you words of counsel and encouragement. It is a pleasing office assigned to the Assistant Secretary, that he shall come to Newport, and by his presence at the opening exercises testify to the unabated interest felt by the Department in the growth in usefulness of the Naval War College. So far as good wishes avail, permit me to assure you that I bring them in fullest measure.

This institution, young as it is, has amply justified its existence. No thoughtful observer, I feel sure, whether in or out of the service, can fail to perceive that as graver problems of naval administration from time to time present themselves, under conditions ever varying, they demand for solution influences that can be fostered and perfected only through means to be supplied by a college such as this.

For the privilege of responding to your invitation, I am duly grateful. The occasion demands the best that one has to give. I am not a little concerned, however, as to the line of thought adapted to my capacities, and therefore most appropriate to pursue. It is usually expected of an opening address that it shall strike a keynote. This, I confess, I cannot do. Surely it is not for a worker taken up on the rolls at the eleventh hour to harbor any such ambitious purpose.

It was of Lord John Russell, you remember, that Sydney Smith rather teasingly said:

"There is not a better man in England, but his worst failure is that he is utterly ignorant of all moral fear; there is nothing that he would not undertake. I believe he would perform the operation for the stone, build St. Peter's, or assume (with or without ten minutes' notice) the command of the Channel Fleet; and no one would discover by his manner that the patient had died, the church tumbled down, and the Channel Fleet been knocked to atoms."

There may be Lord Johns in the country at large, but we have not been making assistant secretaries of them—at least, not lately. With your permission, then, I shall speak from the standpoint of the average American citizen.

Our Navy has never been intrenched more firmly in the popular heart than at this very hour. Time was when admiration for our sailors found a home chiefly along the seaboard, but to-day it knows no bounds of locality. Coast and interior alike pulsate with a thrill of patriotic fervor for glorious achievement. The peaks of the Rockies, as it were, catch the spray of inspiration. No village in the land is so remote that the guns of Dewey and of Sampson have not awakened gladdening echoes within its borders.

The average American citizen, though he may be a little mystified at its technique, is proud of the Navy. The factory hand at the loom, the miner delving with the pick, the settler as he drives a furrow through virgin soil, each voicing that intelligence wherein lies the hope of the Republic, feels somehow that for him the Oregon in Manila bay, the Kearsarge and the Alabama (names now linked in perpetual love for the Union), mean protection and peace. He is conscious that their sleeping force warrants a surer return for his honest toil.

Let a word or two be said, therefore, in harmony with this broader apprehension by our whole people of what the Navy stands for. Now that the sphere of our responsibility as a nation has widened, and populations heretofore strange to us rely upon the protection of the American flag for an advance of civilization, and for the blessings of a stable government with political freedom, it is plain that new duties are required and will continue to be required of our commanding officers in distant waters. It behooves us, then, to ponder well the inquiry, How shall the Navy officer of the near future best meet the demands that his country has laid upon him? Such is the question you study here to answer.

It is curious to note that two branches of the service which have so much in common should differ widely when brought to a definition. Speak of the army, and you call before you a body of men armed and trained. Speak of the Navy, and we picture to ourselves ships armed and furnished with officers and crews. That is to say, while the former means men, the latter brings up the material instrument with which men work—a ship and her guns—rather than the man himself. But the world has personified a ship from the days of Homer down. The custom ought not to blind one to the truth that the ship and her armament is, after all, but so much inert matter. It is the man, the brain of man, that is everything.

You will pardon the allusion, but I shall not soon forget the experience of one bright, lovely afternoon in May when I saw a double-ender gunboat, her flag to the breeze aloft, dashing like a race horse—almost leaping—through the waters of a Carolina sound, until she crashed upon the iron sides of our formidable antagonist, the rebel ram Albemarle. It was not the Sassacus, but the intrepid Roe, that did the deed.

That we may have peace you teach war. You hold officers to the one central fact, that the Navy means organized preparation to crush an enemy. It means that men and material are ready upon the instant.

When Napoleon was asked why his first Italian campaign was the most successful of all his campaigns, his reply was: "Because it was most carefully studied out beforehand." All the book learning in the world might fail to create a successful captain, and yet the leader who can profit by the experience of others has the advantage of him who relies altogether upon his own intuitions.

So here you proclaim that study and hard thinking are in order. A battle on land or water means that somebody has been working out a plan. These various plans in time have evolved rules and maxims based on certain principles that prove of more or less value as guides for future action. What these rules are, how best to apply them, when they can be safely violated—these, and such as these, are vital topics with which the Naval War College deals. All that is intellectual in the make-up of the officer responds gladly to the prospect of an exercise thus invigorating and broadening.

In war, as in every other struggle, the test of success is that the commander works out the largest results possible with the instrument put into his hands. He that waits that he may have something better to go ahead with never wins a battle. The effective force to be got out of a ship depends on the man who handles her. These, to be sure, are but commonplace observations, but, nevertheless, the idea they embody ought ever to be present to the mind of an officer fit to command.

Obviously, the naval profession lies open to very much the same influences that operate in other professions. If there be a leading factor that accounts for the marvelous changes in the latter half of the century now hastening to a close, we shall recognize it in the multiform facilities that have come into being for intercommunication. People sometimes say that the world is smaller than it used to be. The truth is that, while distances seem smaller, the world, as comprising the circle within which people move about, is larger than ever before. A man lives over a wider range of territory, and comes into actual contact with incalculably more people than did his grandfather, or even his father. The problems of the hour are not only more intricate, but far more numerous, than those of five and twenty years ago. Hence, if one would master a few subjects, instead of getting a superficial acquaintance with many, he must give up the hope of covering a wide field. He becomes a specialist. Such is the inexorable decree of these later days. In business or in science the few who stand at the head have gained distinction by reason of knowing more about some one thing than anybody else.

In the slow and painstaking process of training officers of the Navy, can we hope to escape the workings of this law? Observe, I refrain from expressing an opinion. I merely submit the inquiry whether it be the part of wisdom to attempt to run counter to the workings of what clearly is the trend of development in the higher walks of business, of science, and of the learned professions.

There can be no lowering of the standard. Matchless as is the record of past achievement, the captain of the future must subject himself to a test even more rigid. He shall evince more ardor than Paul Jones; more skill than Hull; more daring than Decatur; more firmness than Farragut.

First, and always, he shall be a sailor—shall excel in seamanship. Sails and topgallant masts have disappeared, but the mystery of the ocean remains. To read wind and current; to have his ship in hand through storm and calm; to keep her staunch and trim, and at her best—this is to be in truth a sailor. The aphorism of better than a century ago has not lost its point, that "The winds and waves are always on the side of the ablest navigators."

Your officer is to carry a stout heart—shrink from nothing—take the risk. He must harbor a comprehension of that miracle of human ingenuity beneath his feet, the modern battleship—her build, her motive power, her every capacity, her death-dealing guns, her armor shield, her nicely adjusted mechanisms, the almost countless nerves trembling with life and meaning. He must be able to boast some acquaintance with chemistry, electricity, hygiene, some familiarity with diplomacy, and with the outlines of international law. We would have him conversant with human nature under a blue flannel shirt. A master of discipline, it will go hard with him if he do not possess decision of character to a rare degree of perfection.

See what a list of virtues you are making out for the brain of one man to keep in exercise. If a note of warning lurk in these suggestions, it is that we take precious good care lest our judgment of the Navy be required to accomplish too much.

Dr. Johnson is every now and then quoted as having said: "Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it." In like manner, it is to be observed, that while the commander of a ship may have mastered fairly well one or two subdivisions of the many affairs under his control, he sees that for this or that other department, of which he knows something, he can rely upon a subordinate who is specially trained therein.

Let us avoid imposing upon a ranking officer a burden of multitudinous details. His talent and energy are pledged to a service infinitely more important. His business is to study deep, and again and again to reflect upon, the problem how to perfect himself in the use of that which his country has intrusted to him wherewith to meet and destroy the enemy. This is to compass the art of war in a larger aspect, to rise above what is petty, and to deal with what is grand and enduring.

You will observe thus far we have had in mind the commander of a single ship only. A course of training to fit the officer for this responsible post is begun at the Naval Academy, and continued after graduation for every day that he is on duty.

But the aim of the Naval War College is to lead him onward and upward, that he may grasp the full meaning of the problem how to bring many ships together into the squadron, or the fleet, and then how to deal with them thus combined and unified.

Who can say of this or that young officer that he may not on some bright morning in the future meet the crucial moment of his life at the head of a line of battleships? He who wears the uniform must in all seriousness ask himself, "What am I to do if I have a campaign to plan, a victory to gain?" There is but one answer: "I must consult the past. I must gain ready knowledge of what the great sailors of history have done. I must look with clear vision into the principles upon which they went forward to the honor and glory of their country."

Such is the lofty theme to which you here would dedicate the thoughts of your noble profession. Nor is it too much to hope of those who resort hither that each in turn will find himself inspired with the determination to walk "Along the far Eastern uplands, meditating and remembering."

Therefore it is that we bid a hearty Godspeed to your work. Mr. President, may you, and those associated with you, sir, enjoy the rich reward of seeing that work fruitful of the best results to the service and to the country.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

AN ACCOUNT OF SOME PAST MILITARY AND NAVAL OPERATIONS DIRECTED AGAINST PORTO RICO AND CUBA.

By CAPTAIN C. H. STOCKTON, U. S. Navy.
President of the Naval War College.

The waters of the West Indies and Caribbean have been the battleground for various European nations for several centuries. Although not as rich in historic associations as the Mediterranean, to which it has not inaptly been compared, still, the insular or isolated nature of the bordering countries of the Caribbean has caused the warfare in these countries to be very largely and primarily of a maritime nature. When the interoceanic canal is constructed, not only will the importance of these waters be magnified, but the latter-day similarity to the waters of the Mediterranean greatly increased.

The West Indies have been the nursery for great English seamen; Sir Francis Drake, Anson, Hawke, Rodney, Howe, Hood and Nelson all served and distinguished themselves in these latitudes. While the East Indies and British India have been the training ground for English soldiers, the West Indies have served in the same manner to develop the English naval leaders of past centuries. In our own history, the Perrys, both Porters and Farragut have all spent much of their sea lives in the West Indies and along the Spanish Main, and during the late war with Spain the backbone of the sea power of Spain was broken by the Admiral who still quietly awaits the recognition of his work by the country he served so well.

It is not my intention to recount all the operations, large and small, that have occurred in or about Cuba and Porto Rico—

now under the American flag and sovereignty, but to recount the principal operations in times past against San Juan de Porto Rico, Santiago de Cuba, and the city and port of Havana. It happens that these operations have been under the English flag and carried on in the several wars between England and Spain during parts of the sixteenth, seventeenth and eighteenth centuries. In at least two of the expeditions, that against Santiago in 1741 and the one against Havana in 1762, there were contingents from some of the English North American colonies now within the area of the United States. The first expedition, in point of time, was that against the capital of Porto Rico, San Juan, in 1595.

On the 28th of August of that year, a fleet of 27 vessels, under the joint command of Sir Francis Drake and Sir John Hawkins, left Plymouth, England, for the West Indies and Central America. With the expedition were land forces numbering 2600, under the command of Colonel General Sir Thomas Baskerville.

In the early days of the formation of the expedition, its objective point was the Isthmus of Panama; but shortly before the time of sailing the commanders learned that a Spanish treasure ship, in a crippled condition, had put in for shelter at San Juan and there dismantled and disarmed. She remained with two millions and a half of treasure in her hold from the rich mines of Mexico. Queen Elizabeth, who was interested financially in the expedition, ordered that, if possible, the treasure ship with her cargo should be captured.

The evils of the joint command under which this expedition was placed came very soon to the front. Sir John Hawkins carried his flag on the Garland, and Sir Francis Drake, much younger in years, flew his flag on the Defiance, while, according to the arrangement made before sailing, the council of war was to meet alternately on these two ships, beginning on board that of the elder officer. Before reaching the coast of Spain, the question arose as to the first objective: Drake desired to begin with the Canary Islands, but Hawkins thought such an attack unwise and inexpedient; Baskerville siding with Drake the latter carried the day, but almost at the expense of an open rupture. The repulse that followed the attack upon the Canaries did not mend matters.

However, on the 29th of October, the fleet, with the exception of two small vessels, arrived at the island of Guadeloupe in the West Indies. Unfortunately, five Spanish frigates, sent to bring home the delayed treasure in Porto Rico, fell in with the two belated vessels, capturing one and chasing the other until she joined the main body, thus discovering the position and force of the English fleet. Learning the destination of the fleet, by torture it is said, from the captured vessel, the Spanish commander crowded all sail for Porto Rico to notify the authorities at San Juan of the coming of Hawkins and Drake.

Drake immediately saw the disastrous result of this discovery and capture, and was at once anxious to get underway, pursue and attack the Spanish frigates. Hawkins, however, refused to consent, and Drake in vain urged upon his old kinsman the vital importance of rapid action. Hawkins, however, was sick and infirm, and Drake could not press him too far, so the fleet remained for refitting and for the remounting of guns stored below for the transatlantic voyage.

When the fleet finally sailed, Drake delayed again at the Virgin group, to find another passage through, besides the one usually taken, and at which were placed the lookout vessels of the Spaniards. Another channel being sounded out by him in his own barge—known to this day as Sir Francis Drake's Channel—between the islands of Virgin Gorda and Tortola, the expedition passed in rear of the small Spanish scouting vessels and came within sight of San Juan without the immediate knowledge of the authorities, though the arrival of the Spanish frigates had conveyed the general information as to their aim and former whereabouts.

When, however, Drake and his fleet—soon to be his alone—arrived off San Juan, matters there were in a good state of preparation for defense. Don Pedro Tello, the "general" of the frigates, was placed in charge of this defense. His troops were landed from the frigates to reinforce the garrison, additional artillery had been mounted and two large vessels, of which the dismantled treasure ship was one, were sunk at the mouth of the harbor and a boom constructed upon them to complete the barrier. The treasure had been placed on shore, in the citadel, in the meantime.

Drake and his fleet were sighted from the city at the daybreak of the 12th of November, and about this time Sir John Hawkins passed away, leaving Drake sole commander-in-chief. As the English fleet came up with the light morning breeze increasing in strength, a caravel was seen preceding it with numerous small boats sounding and signalling the way.

The city of San Juan is built upon a rocky promontory at the end of a long island, which makes the harbor and its connecting interior waters. This island, almost a peninsula, running in a general easterly and westerly direction, is separated by a small inlet known as the Boqueron, which has always been commanded by some sort of fortification.

At the west end of this peninsula, directly at the rocky site of the old town, is the entrance to the harbor, at this point having a navigable channel of 500 yards in width only, but opening out behind the town and promontory and presenting a good harbor in depth and security for vessels of moderate draft of water.

Five years before the arrival of Drake, the place had been strongly fortified and at the time was held to be one of the strongest ports in the West Indies. The entrance was commanded by the Morro and the Rock battery, and the usual town landing place by Sta. Elena battery. To the eastward of the town were works known as the Morillo and Cabron, while the shore end was defended by the work at the Boqueron, and at the head of a causeway or bridge was Fort San Antonio, covering the only approach from the mainland to the island upon which the city was placed.

In all, the defenses at this time mounted seventy guns and the garrison consisted of 1500 Spanish regulars, besides a force of about 8000 colonials capable of bearing arms.

Approaching from the eastward along the coastline, the boats in advance of Drake's fleet, with their white flags showing a safe course, soon came within the reach of the fire of the Boqueron, and there showing colored flags, at once stood off shore. The fleet, however, stood on by the Boqueron in close order until it passed Escambron Point, when it came to anchor in a sandy bay, still to the eastward of the town.

The anchoring of the fleet at this place was a surprise to the Spaniards, who at once expected a landing from the fleet. Unfortunately for the English, this sandy bay was covered by the fire of the shore batteries, which at once opened with a fire so hot that Drake had finally to weigh anchor and stand back to the eastward. Drake himself had his stool shot from under him, while two of his principal subordinates were mortally wounded at the same time. As the day closed, the English fleet finally disappeared from sight, and those who knew not Drake thought the repulse a final one.

But in these, his latter days, the spirit of Drake's youth arose in him, and at the following daybreak the Spaniards saw the fleet to the westward of the entrance, standing towards that side of the harbor entrance and finally taking an entrance behind the two unfortified islands of Cabra and Cabrita, which then, as now, marked the western side of the entrance to the port. These islands masked the anchorage of Drake's vessels from the fire of the town batteries.

From this protected anchorage the frigates could be seen close under Sta. Elena battery, so placed by Tello that if the worst came the treasure in the citadel could be put on board and the ships take to sea. Drake determined upon a night attack by boats, with the unfortunate determination of firing them one by one. The first one set on fire so lighted up the neighborhood that the advantage of a night attack was lost, and the boats received the concentrated fire of the batteries to such an extent that the attempt failed with great loss to the English.

Not yet dismayed, the next morning Drake again got underway and worked against the prevailing wind to the eastward, for a favorable position off the entrance. Whatever the others thought, Tello the commander of the defense knew Drake of old, and especially of his former bold operations in the harbor of Cadiz. Suspecting that Drake would attempt to force the harbor entrance beyond the end of the boom, he sunk two heavily laden merchantmen at the extremities, and when Drake finally headed directly for the entrance, he sunk in addition two of his frigates, with all their guns, stores and equipment. Once again was Drake thwarted, and finding an entrance barred, he once more came to anchor near the entrance and called a council of war to consider the question of a landing attack. Baskerville and the majority of the council being against the undertaking, Drake finally abandoned all further attempts and sailed away for the Spanish Main and the Isthmus of Panama, at which place he died in the following January.

The best commentary upon Drake's attempts and failures is, perhaps, the narrative of the Earl of Cumberland's successful attack upon the same place a few years afterwards.

George Clifford, Earl of Cumberland, was one of those distinguished adventurers of the Elizabethan era, who, though not without hope and desire for gain, seems to have been actuated quite as much from a chivalrous love of adventure as from any other motive. His social position and ample personal wealth gave him a standing that enabled him to introduce good order and discipline among his followers in the various enterprises initiated by him, and has caused his attack upon San Juan to be considered "as a fine orderly operation of war conducted with no less humanity than gallantry."

The expedition with which we are concerned was the tenth and last that the Earl of Cumberland had formed, and was accompanied by the Earl in person as admiral and commander-in-chief. Sailing from England on the 6th of March, 1598, with a force of twenty vessels of all sorts, he had for his flagship the famous Scourge of Malice, christened by Queen Elizabeth herself and ranking, with its 800 tons, among the very first vessels of the day. His second in command, styled "Lieut.-General and Vice-Admiral," Sir John Berkeley, carried his flag on the Merchant Royal. As a whole, his force was more formidable, it was said, than any that had heretofore been assembled by a subject of the kingdom.

Arriving at the Canaries, Cumberland took and plundered the island of Lanzarote and then pushed across for the West Indies, arriving at the island of Dominica on the 23rd of May. Leaving there on the 1st of June, the expedition proceeded to the Virgin Islands, where the landing parties were organized and drilled.

Leaving the Virgin group the fleet made the eastern end of Porto Rico and coasted along the north shore of the island until the vicinity of San Juan was reached. The sea being calm, a force of about 1000 men was landed on the beach to the eastward of the town and island of San Juan, observed only by a small group of Spanish horsemen.

A day's march after landing brought the English to the inlet already spoken of as the Boqueron, and to a halt, as boats were wanting to cross to the island. At this time the defenses of San Juan were much the same as at the time of the previous attack, but the garrison that Drake encountered and Tello commanded was much stronger than the one that Cumberland had to deal with. By the disappearance of the Spanish horse Cumberland was led to suspect another approach to the town, and through the aid of a negro guide he discovered the causeway that connected the southeast end of the island of San Antonio with the main land which was covered, then as now, by the small fort at San Antonio. Cumberland gave his men a few hours rest after darkness set in, and they all slept in their armor on the bare ground. Before daybreak, the attack was made under the leadership of Sir John Berkeley. The causeway was rough and the Spaniards were upon the alert and opened such a hot fire that the English were compelled to withdraw at daylight with a loss of fifty men.

On account of the persistent requests of his subordinates, the Earl of Cumberland resigned the leadership of this assault to his second in command, but history tells of his part in the matter. He could not keep out of the fight, and stumbling along the causeway in the dark, he was thrown off his feet and pushed by accident into the water, and falling on his back, encumbered with his armor, he could not get up and would have drowned had he not been fished up, after some delay, by two of his men.

When finally rescued, the historian relates, he had swallowed so much salt water as to be very sick and was obliged, most unheroically to spend the remainder of the night sitting in a state of complete exhaustion by the side of the causeway.

The next attack was made on the fort at the Boqueron, now known as San Geronimo. One of the vessels of the fleet was brought close under the guns of this fort; to do this, she had to be grounded in front of the fort, but the sacrifice of the ship was thought to be justified by the results, and the fort was reduced to ruins, although the vessel was stranded and became a wreck. The assaulting party effected a landing across the Boqueron, and after a march of a mile—the town was much smaller in those days—the town was reached and found to be deserted by all of the population capable of bearing arms, who had repaired to the Morro. This castle was finally reduced, and with the town and the rest of the defenses became subject to the English.

It was Cumberland's original intention to retain possession of San Juan as an English colony, but climatic diseases, principally of the nature of yellow fever, so reduced his command that first he returned to England, leaving Sir John Berkeley in charge, and then Berkeley followed, joining his admiral while still on his homeward route.

A later and unsuccessful attack was made upon San Juan in 1797, by a combined expedition under Rear-Admiral Henry Harvey and Lieut.-Gen. Ralph Abercrombie. The defenses of San Juan had been increased by the redoubts of San Cristobal, and the attack by shore and sea, principally by bombardment, was so ineffective and the assaults so unsuccessful that Abercrombie re-embarked with his force on the 30th of April, after a loss of 225 killed, wounded and missing on the part of the English.

Santiago de Cuba.

In 1741, an expedition was formed in Jamaica to attempt the capture of Santiago de Cuba. It consisted of a fleet of eight ships-of-the-line, one of fifty guns, twelve frigates, some small craft and about forty transports. The fleet was under the command of Vice-Admiral Vernon, with Rear-Admiral Sir Chaloner Ogle as second in command. The land forces numbered about 3400 men and were under the command of General Thomas Wentworth. With this land force were remnants of the American regiment, originally numbering 2500 men. One of the Washingtons accompanied this expedition and Mount Vernon owes its name to the naval commander-in-chief of this expedition.

Guantanamo Bay was selected as the general rendezvous of the expedition, and by the 18th of July the vessels of the expedition had assembled in that bay which was named by Vernon "Cumberland Harbor," after the second son of the reigning monarch, George II.

Guantanamo Bay, which is one of the best and most secure in Cuba and the West Indies, is about forty miles from the entrance to the harbor of Santiago. It is divided into a shoal upper bay and a fine deep-water anchorage in the bay proper. Upon the arrival of the expedition, which took possession of the bay without opposition, the smaller ships-of-war and transports were sent up the harbor as far as the depth of water permitted.

The usual council of war was held upon the day after that of the arrival of the expedition, and considering, from the best information available and from a naval reconnaissance, that a direct attack upon Santiago from the sea was impracticable and that the entrance was closed by a substantial boom, an attack overland from Guantanamo Bay was decided upon.

The land forces consequently disembarked and encamped at the mouth of the Rio Guasco, about three leagues from the entrance to the harbor, and a detachment of 150 Americans and negroes, under Major Gunster, penetrated the interior as far as the village of Elleguava, where it remained for some time until, for want of support, it fell back to the main encampment.

There was at this time assembled in Havana Harbor a Spanish fleet consisting of twelve ships-of-the-line, which constituted an active fleet in being and required the attention of Vernon. Consequently, he sent some of his faster cruisers to watch off Havana Harbor, while with others he blockaded Santiago, and with six of his largest vessels he formed a line across the wide entrance to Guantanamo Bay, to cover the transports within.

Santiago was not over four days march from Guantanamo Bay, by troops lightly equipped, and was almost defenseless on the land side. There was no force of any size to oppose the English troops, but Wentworth did not advance from his encampment. The country was thickly wooded, it is true, and difficulty would have been found in dragging the guns overland, but still it was practicable to have made the march with lightly-equipped troops.

But with the delay came sickness and a letter from General Wentworth expressing his doubts whether to advance farther or to subsist his forces much longer in the part they possessed.

The vice-admiral in person, made a reconnaissance of the entrance and outer works of the harbor, and found little hope of capturing Santiago from the sea. Councils of war followed each other in quick succession, and finally, mutually discouraged, the troops were re-embarked on the 20th of November and the fleet returned to Jamaica.

This campaign has been severely and not unjustly criticised: first, because the attempt was made upon Santiago rather than upon the more important city of Havana, where the enemy's fleet was lying; secondly, because the Spanish fleet in Havana was not masked by the entire force of Vernon; and thirdly, because General Wentworth remained inactive for about three months within less than sixty miles by land from their objective. There seems to be little doubt that more men were sacrificed by delay in that sickly climate than would have been lost by active operations.

The conquest of Cuba seems to have been the desire of the English ministry, for as late as the 23d of September, 1741, Governor Shirley, of Boston, made a speech inviting New England settlers to go to Cuba, promising grants of land to intending settlers. This seems to have been the first of the movements (allied to filibustering) towards Cuba from North America.

One of the great evils of this expedition was a want of harmony and co-operation between the army and navy, especially between the two leaders. On the 31st of October, the Duke of New Castle wrote to Vice-Admiral Vernon as follows:

"His Majesty has commanded me to acquaint you and General Wentworth that he sees with great concern the heats and animosities that have arisen between his officers by sea and land, contrary to his orders, whereby the service cannot but greatly suffer; and I am ordered to recommend to you in the strongest manner carefully to avoid the like for the future, and that in case of any difference of opinion all acrimony and warmth of expression should be avoided."

In 1748, a naval attack was made upon Santiago de Cuba by a fleet under the command of Rear-Admiral Sir Charles Knowles. The entrance of the harbor was closed by a boom backed by vessels held ready to be used as fireships. The defenses had been strengthened since 1742 and the Spaniards were aware of the intended attack. The nearest forts were cannonaded by the English and the fire was returned, and the leading ship finding that it was impracticable to proceed, reported to the admiral, who finally withdrew and returned to Jamaica.

THE SIEGE AND CAPTURE OF HAVANA IN 1762.

In January, 1762, war was declared by England against the Kingdom of Spain, and the existing ministry of Great Britain found themselves obliged to adopt the plans for the war formulated by the elder Pitt, who had shortly before resigned from the ministry of which he had been premier.

The plans adopted included a campaign in the West Indies, with the settlements of the Spanish in that region as objectives. Havana was the main objective, being then the center of their colonial trade and the key to their American possessions.

The Earl of Albemarle was selected for the chief command of the land forces, and Sir George Pocock, Admiral of the Blue, was appointed to command the fleet, while Commodore Augustus Keppel, a brother of the Earl of Albemarle, was appointed second in command and placed in immediate charge of the fitting out of the force in England.

The British ministry lacked the impelling genius of Pitt, and the sailing of the expedition from England was unnecessarily delayed until the 5th of March. This delay caused the principal operations to take place in the summer, and might easily have caused the siege to last until the hurricane season—so dangerous to the sailing ships of that day on a shore like that to be found on either side of the entrance to the harbor of Havana.

The army was to consist of 16,000 men, but of these but 4000 were to sail with the commander-in-chief from England. Eight thousand were to join in the West Indies and four thousand were to be furnished from America by Sir Jeffrey Amherst, then stationed at New York. Two thousand of these last were to be colonists or provincials, to be raised by General Amherst from the colonies of New York, New Jersey, Connecticut and Rhode Island, with a quota from each according to population.

Sir George Pocock sailed with but five line-of-battle ships, the remainder of his naval force was to be constituted from the forces under command of Admiral Rodney and from a squadron under Captain Hervey, both being in the West Indian waters.

Upon the arrival of the fleet at Barbadoes, Admiral Pocock, hearing of the capture of Martinique by the combined forces of General Monckton and Admiral Rodney, repaired to that place. The news of the capture of Fort Royal in this island had been taken home by Major Gates, the senior aid-de-camp of General Monckton. Gates afterwards came to greater celebrity during our Revolutionary War, as the American general in command at Saratoga.

By the combination effected at Martinique, the army amounted to over 11,000 men and the fleet of forty vessels of war of all classes, with 156 storeships and transports. Admiral Pocock carried his flag on the Namur, of 90 guns, and Commodore Keppel on the Valiant, of 74.

Sailing from Martinique on the 6th of May, and joined off Cape St. Nicholas by the contingent from Jamaica, two routes to

Havana presented themselves to the admiral: one the ordinary and most secure route along the southern side of Cuba, and the other on the north side of Cuba, little known, unmarked by any aids to navigation and bordered on either side by dangerous shoals—by means of what is now known as the old Bahama Channel, which was in length about 600 miles. During our late war, an accommodating enemy kept this channel lighted on the Cuban side, while the neutral government of the colony of the Bahamas marked in the same way the northern edge.

As celerity was essential to the success of the enterprise, the admiral chose the latter as the more speedy, even though more hazardous, route.

To keep the formation compact and well within control, the combined fleet was formed in seven divisions and without pilots and with, as a principal guide, an old chart of Lord Anson's, beacon lights and ships were placed upon the principal cays and shoals for day and night passage. While in this channel two Spanish vessels of war were captured, but a schooner escaping at the same time carried to the governor of Havana the news of the approaching fleet and threatened attack.

The composition of this large fleet, as it passed through the old Bahama Channel in a direction opposite to that taken by our own Santiago expedition through the same channel, is interesting and worthy of mention. The expedition sailed in a formation of seven divisions and in three columns. The van division consisted of five men-of-war, Sir George Pocock leading in the center with his flag on the Namur. The flanking columns were also men-of-war, the rear being brought up by three vessels of the fleet.

The central column consisted of transport and storeships, hospital and artillery ships, two ships with negroes from Jamaica, some brought as slaves and some loaned by the colony, four ships with fascines, three with horses only, and six with the baggage of the general officers. During the delay at Martinique, the men had been employed in cutting wood for fascines, the soil in the vicinity of Havana being very thin.

The land forces had been divided into five brigades, and exclusive of the reinforcements that came later from New York under Brig.-Genl. Burton and the detachments from Jamaica, amounted in round numbers to 12,000 men. Among the officers of these forces whose names became known afterwards in our Revolutionary War were the Adjutant-General, Col. William Howe and the Quartermaster-General, Col. Guy Carleton.

The expedition had fine weather in passing along the north side of Cuba, and on the evening of the 5th of June, 1762, cleared the channel and sighted Matanzas. On the 6th, the fleet hove to about five leagues to the eastward of Havana to make the necessary preparations for landing. Commander Keppel was appointed to take charge of the landing operations, having assigned to him six ships-of-the-line and some frigates; the flat-bottomed boats to be used for landing the troops being manned by men from the fleet.

The admiral here parted company from the rest of the expedition, and taking 13 ships-of-the-line, 2 frigates, the bombketches and 36 storeships, ran down off the harbor, finding inside twelve Spanish ships-of-the-line and several merchant vessels. The next morning the admiral embarked the marines in boats and made a show of landing, about four miles to the westward of Havana. About the same time, the Earl of Albemarle landed with the whole army between the small rivers of Bocando and Cojimar, about six miles to the eastward of Morro Castle. The army landed in three divisions, in command of Lieut.-Genl. Elliot, Major-Genl. Keppel, and Brig.-Genl. Howe; Lord Albemarle going ashore in the barge of the Valiant with Commodore Keppel.

While the disembarkation was going on the enemy made a show of resistance, but they were soon put to flight by a fire from two of the ships. A large force making their appearance they were dispersed, and the small redoubt at the mouth of the Cojimar River silenced by Captain Hervey in the Dragon, and the army landed without further disturbance.

The greater part of the Spanish infantry and all their cavalry took post at the village of Guanabacoa, in order to prevent the British forces from getting around the head of the harbor and thus attacking the city on the west side. This force was dislodged by the advance of the British and the village and grounds of Guanabacoa held under Genl. Elliot from thenceforth, to cover the besieging parties from attacks from inland.

On the 10th, Lord Albemarle wishing to occupy the hill of the Cabanas, then surmounted only by a small redoubt, had a feint made upon the fort at the Chorera, which diverted the Spanish so that the castle at Chorera was abandoned while the ridge of the Cabanas was carried with very little loss.

As the chief fortification of Havana and of its harbor entrance was Morro Castle, the principal attack was directed against this work, the operations being placed in charge of Major-General Keppel by his brother, the commander-in-chief.

At this time, the garrison of Havana consisted of 810 cavalry, 3800 infantry and artillery, and 9000 sailors and marines belonging to the fleet, making the number of the regular forces over 13,000; to these were added 14,000 militia and people of color, making a total force of 27,610 men of all arms and kinds.

Morro Castle being of the greatest consequence was, on account of the scarcity of regular artillery, garrisoned by and given in charge of the navy, under the command of Don Luis de Velasco, captain of the Reyno, ship-of-war. All the English historians agree in saying that he discharged this important trust with a courage and fidelity that has rendered his name immortal.

The Marquis de Gonzales, captain of the Aquilon, ship-of-war, was appointed second in command and proved to be worthy of his chief.

On the 8th of June the Spaniards sunk one of their largest ships in the narrow entrance of the harbor, and on the 9th a second ship was sunk at the entrance and a boom was placed across the mouth of the harbor. At a still later date the harbor was completely closed by the sinking of a third vessel. This, of course, practically threw out of action the entire Spanish fleet, which was not far in number of vessels of the line from the English fleet.

I cannot do better than repeat the comment made upon this policy by a writer of those days who says, "though the issue of a naval battle might have proved unfavorable (to the Spaniards), yet a battle tolerably maintained would have disabled our armament and perhaps have been a means of preventing the success of the whole enterprise. The loss of their fleet in this way might possibly have saved the city; but the city once taken, nothing could possibly save the fleet."

The main battery constructed in the siege of Morro Castle was placed as near as the cover of the surrounding woods permitted, and at a distance of only 250 yards. The soil was so thin that it was with great difficulty that the besieging parties could cover themselves in their approaches, and the battery had to be erected of wood and other inflammable material, including old rope cables from the ships, etc., and bales of cotton brought from Jamaica. The supply of water was scarce and brought from a distance, and late in the siege they had to have recourse to water from the ships.

In addition to the battery bearing on the Morro, another battery of howitzers, on the Cabanas, was erected to bear upon the ships in the harbor, to stop their fire upon the men working in the approaches. This eventually caused the removal of the Spanish fleet to the upper end of the harbor. On the 13th, an actual landing was made at Chorera, to the westward of Havana, by grenadiers and light infantry, under Col. Howe, of Brandywine fame, to which was added a force of marines from the fleet. This engaged the attention of the enemy to that side and it was off this part of the shore that the main body of the English fleet remained at anchor.

It was not until the 29th of June that the batteries were ready to open fire upon the Morro and shipping. Early on this day, however, an attack was made upon the British position on the Cabanas, by a large detachment from the city, which had landed near the Morro. This attack was repulsed with great loss to the Spaniards.

On the 1st of July, a combined attack was made upon the Morro by sea and land. The shore batteries of guns, mortars, and royals, opened fire from four positions, while the ships Cambridge, Dragon and Marlborough, under Captain Hervey as senior officer, took position close to the shore and opened fire at the Morro at 8 a. m.

This was continued until 2 p. m., when the ships were obliged to haul off. The Cambridge, which was within grape shot distance, had lost her captain, 24 men killed and 95 wounded, while the losses on the other ships brought up the total casualties to 42 men killed and 140 wounded. The position of the Morro on a high and steep rock gave a plunging fire on the ships, to which was added the cross-fire from the Punta and other batteries on the town side. The fire from the ships, however, proved of assistance in relieving the fire upon the land works. The Stirling Castle was ordered to lead until the first ship was properly placed and then to make sail off, but this was done so badly that the captain was courtmartialed and cashiered for his action, after the siege.

The fire of the land batteries continued on the 2nd and 3rd of July, but on the latter day the principal battery before mentioned caught on fire and was entirely destroyed.

By this time, the climate, aggravated by bad provisions and scarcity of water, began to tell on the troops, and no less than 5000 soldiers and 3000 seamen were down with various complaints.

The mistake of erecting the main batteries too near to the Morro was remedied in the erection of the new batteries, which were placed at double the distance. Fire was continuous from these batteries, one of which was again destroyed by fire, and the sappers and miners approached the walls of the fort, though much hindered by a ditch seventy feet from the edge of the counterscarp, upwards of forty feet of that depth being sunk in the rock. Fortunately, there was a thin edge of the rock left to cover the extremity of the ditch from the sea, and by means of this ridge the miners passed with difficulty to the foot of the wall.

On the 21st of July, it becoming evident to the Spaniards that unless something effective was soon done the Morro would fall, the governor determined to make an attack upon the besieging work on the Cabanas, the key of the position, and driving out the English, destroy them by fire. Had this succeeded, with the sickly condition of the troops and the delay in the arrival of the North American contingent, there is little doubt that the siege would have been raised. The attacking party came from the town, landed on the Cabanas side and began the attack at four in the morning. This attack was repulsed with heavy loss, Col. Sir Guy Carleton, Brigadier-General of the day, who was wounded, receiving great credit for his active services in the repulse.

On the 28th of July, Brigadier-General Burton arrived with the first division of the troops from North America, which had sailed from New York on the 11th of June, but on the 24th of July five vessels of his expedition were wrecked off the Bahama Straits.

On the 30th of July, the mines under the walls of Morro were fired, making a breach that was considered practicable, and an assault was ordered. Don Luis de Velasco defended his charge to the last, and in endeavoring to rally his men was mortally wounded while coming up the slope of the rampart. In such high esteem did the King of Spain hold this brave officer and his brave defense, that he not only ennobled his son by creating him Viscount Morro, but also ordered that there should always be a ship in the Spanish Navy named the Velasco. The last vessel to hold that name continuously in the Spanish Navy was captured by the fleet under Admiral Dewey at Manila, on the 1st of May, 1898.

Marquis Gonzales, the second in command, was also killed in the assault, which was successful after great loss to the garrison. The possession of this fort cost 44 days of hard labor from the time of the first operations, during which time the Spaniards lost 1000 men. The Morro, with its neighboring works, mounted above 154 guns and 11 mortars.

On the 31st of July and the 1st and 2nd of August, the Spanish opened a heavy fire from the north side upon the Morro and sent down a 70-gun ship into the entrance and moved her opposite the Morro, to assist in the cannonading.

On the 2nd of August, the second division of transports, which sailed from New York on the 30th of June, arrived off Havana. This force, with the previous arrivals, was ordered to the west side of the entrance, where direct operations upon the town were proposed. These troops included 2000 provincials from New York, New Jersey, Connecticut and Rhode Island. In the first detachment, among others was Israel Putnam, then a Lieutenant-Colonel of the Connecticut Provincial Regiment, while in other detachments many other names are found who served in the Revolutionary War. Part of the second detachment, including 150 provincials, was captured by a French naval force on the 21st of July. As the New York detachments arrived so late in the siege, their loss from casualties was small, being but seven killed and wounded, but the losses by disease were very large.

From the fall of the Morro until the 13th of August, batteries were established on the west side of the entrance and the fort at the Punta silenced. Finally, on the 13th of August the capitulation of the city and fleet was agreed upon and duly signed.

By the capture and destruction of the vessels in Havana, Spain was deprived of nearly one-fifth of her whole navy, while in prize money the English army and navy acquired an amount of three millions sterling, the Earl of Albemarle and Sir George Pocock each receiving nearly £123,000, while the proportion of each enlisted man and private was less than £3 apiece.

The great disproportion between the prize money of the superior officers and the men in the navy was a source of discontent in the service, and one of the grievances that, in later days, caused the mutinies in the Napoleonic wars.

Apropos of this, an old anecdote was told in these times of a sailor who, previous to an engagement, was seen by a lieutenant to be, as he thought, hiding behind the gun. "You are funking, sir!" said the officer. "No, I am not," said the seaman, "I am praying." "Praying, sir! what are you praying for?" inquired the officer. "Why, sir," said the sailor, "I'm praying that the enemy's bullets will be shared out like the prize money—that most will go to the officers."

The harmony and unity existing between the land and naval forces at the siege of Havana contributed greatly to the success of the undertaking and sets an example not to be ignored to the present day and to our own country and sister services.

The Earl of Albemarle, in his report, stated that "Sir George Pocock and Commodore Keppel have exerted themselves in a most particular manner, and I venture to say that there never was a joint undertaking carried on with more harmony and zeal on both sides," while Vice-Admiral Pocock said, "It will be as needless, as almost impossible, for me to express or describe that perfect harmony that has uninterruptedly subsisted between the fleet and army from our first setting out. Indeed, it is doing injustice to both to mention them as two corps, since each has endeavored, with the most constant and cheerful emulation, to render it but one."

In concluding the account of this siege, let me quote from the biographer of Commodore Keppel, who says that

"Never in this or any preceding war had so valuable and important a conquest been achieved; but dreadful were the sufferings and great the mortality attending it. By Lord Albemarle's official return, on his leaving the Havannah, of the casualties of the army from the 7th of June until the 8th of October it appears that 560 men were killed or had died of their wounds and 4708 had perished from sickness."

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Out of the six operations mentioned in this article, by the English against San Juan, Santiago de Cuba and Havana, but two were entirely successful, so that a comparison with our own late war in Cuba and Porto Rico is not to our disadvantage. But I trust that there are other teachings in such historical accounts than that of self-congratulation. The obligations that have arisen with our new dependencies are greater than any strength that arises from them, and it is well to study the necessities that will arise for their maintenance and defense.

History, now and ever, teaches us by example, as much in the military as in political art. As Prince Bismarck once said in his blunt way, " Fools say that you can only gain experience at your own expense, but I have always contrived to gain my experience at the expense of others."

To this remark let me add one of a French writer that " Peace is the dream of the wise; war is the history of man."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE PACIFIC SUBMARINE CABLE—SOME REMARKS ON THE MILITARY NECESSITY AND THE ADVANTAGES OF A NATIONAL CABLE.

By LIEUTENANT JOHN HOOD, U. S. Navy.

One of the greatest projects before the Congress of the United States, and one that is destined to have the most far-reaching and important influence on the future commercial development of the country, and, greater still, on the military and strategical power thereof, is the establishment of a trans-Pacific cable, connecting the seat of government with its newly-acquired island possessions; and, through them, directly with China and Japan and all the great undeveloped East.

For many years projects have been considered and discussed in Congress, in a desultory kind of way, for the laying of a cable from the West Coast to Honolulu, but no definite action has been taken. The nearest approach to real action, up to this time, was the passage of an act, March 2, 1891, providing for a deep-sea survey, to determine the practicability of laying a cable from California to the Hawaiian Islands, which survey was promptly made by the U. S. ships Albatross and Thetis, and the practicability of the route clearly demonstrated and reported to Congress.

There the matter rested as far as anything practical was concerned—though bills for the construction of such a cable were frequently discussed in the various succeeding Congresses—till after the close of the Spanish war and the annexation of the Hawaiian and Philippine Islands.

This war, and the lessons it taught of the great rôle that cables will be called upon to play in all future conflicts, as well as their great peaceful rôle of extending and promoting commerce in our new island possessions, seem to have waked up our legislators again to the importance of the question, and in April, 1899, the U. S. S. Nero left San Francisco to extend the survey, already made as far as Honolulu, from that point to the Philippines and Japan, by way of Guam, one of the Ladrones, an island especially seized in the war by our government with a view to its future cable uses.

This survey, the most complete and extensive deep-sea cable survey ever made, was completed in February of the present year; and the practicability of a complete trans-Pacific cable definitely settled forever in the affirmative.

It would now seem, in view of the importance of the question to the whole country, that prompt and effective action would follow. And, in fact, it did for a time seem probable. The Senate Naval Committee, with very commendable promptitude, drew up and reported to the Senate a bill, S. 2, that was quickly passed by that body, for the laying of a government cable under the auspices of the Navy Department (to be operated by the Postmaster-General after completion) from San Francisco to Honolulu, with a view to its future extension to the Philippines and Japan.

The House Committee on Interstate and Foreign Commerce also got promptly to work, but on different lines, and reported a majority bill, H. R. 2980, providing for the laying of a Pacific cable by a private corporation, with a government subsidy of $300,000 per annum for twenty years. This bill has not yet been acted on, nor has Senate Bill 2 been acted on by the House further than to be amended by the Committee on Interstate and Foreign Commerce by having H. R. 2980 substituted as an amendment.

There the matter rests, and it may be safely said all cable legislation is dead for the present, and is more than likely to remain dead for a long time to come, while a merry fight goes on between the opposing ideas of government and private ownership.

For a question of such magnitude and far-reaching influence on the future of the nation, the lack of public interest manifested in its discussion is amazing. One looks through the leading magazines in vain for an intelligent article on the subject; and even the daily press gave it a very scant notice during the time of its discussion in Congress, and none at all since.

It is in the hope of awakening a respectable public interest in the question, by demonstrating the military necessity and advantage of a national cable, that this paper is written. Recent experience, during the Spanish war, has been so striking and conclusive, to any one who has studied the rôle of cables, that it would be criminal carelessness to fail to point out its lessons and sound the note of warning to the country.

The only matter of any value on the subject of a Pacific cable that has appeared in print, on this side of the Atlantic, is contained in the papers and evidence submitted to the Committees of Congress considering the cable bills. In all these papers and hearings, very insufficient consideration—practically none—has been given to the importance of the military and strategical side of the question.

Questions of practicability, cost, expense of maintenance and repair, commercial advantages, etc., have been fully discussed from one point of view or another; but little, if anything, has been said of the military and strategic advantages of cable.

That this point was not more fully discussed and elaborated by the advocates of a private cable is hardly a matter of wonderment. Questions of strategy and military strength are so purely national, and so far removed from the plain business motives of dollars and cents, that it would hardly enter their calculations; and, moreover, a full discussion of them would work very much to the detriment of their projects, by demonstrating the incontestable advantages, from a military point of view, of a government-owned cable. That the advocates of a national cable, however, have not brought out this side of the question in its strongest light is a matter of surprise to any one studying the subject.

Since the ratification of the treaty with Spain, and the acquirement of our various island possessions, the nation has entered on a new era. It is claimed, and truly, that we have been a leading nation in the world's affairs for many years. But, nevertheless, the Spanish war brought us to a parting of the ways, and we have chosen the one that leads onward and forward. We have started on a new path from that followed by our forefathers—one from which there is no turning back, except at the cost of retrogression and national degeneration.

Whether we, as individuals, deplore the change or not, it has come, and come to stay. We have been slowly and silently following the great law of evolution, developing from small to great, from great to greater; and the last touch has launched us finally among the contending powers of the world, struggling for the greatest. We must take our chances in this struggle and advance always, or retrograde and die.

Considered as a war, the war with Spain was almost insignificant; but, considered as a source of influence on our national life, its magnitude can be hardly calculated. Just as the results of the war itself expanded from the simple intention of freeing Cuba, to the acquirement of a vast island empire, extending from the West Indies to the China Sea; just so the nation has expanded from one almost hermit in its tendencies to one of the overshadowing powers of the world.

We have left our own isolated ocean-bound coasts, and have reached out across the seas, until we have put ourselves in contact with all the great world powers now struggling for control in the enormous undeveloped markets of the great unwieldy East. And in this East lies the field of the future struggle for supremacy, both political and commercial; and in this struggle we must take our part, and continue to advance, or else join the nations whose race is already run, and weakly view those of more vigorous fiber outstrip us, while we sink further and further behind.

Beyond these two—to advance, grow and live, or retrograde, sink, and die—there is no further choice. From the earliest dawn of history to the present day, the law has been the same; from the instant a nation ceases to advance, its day is done. It may linger on for decades or centuries, but its glory and vigor have departed; decadence has begun, and it is only a question of time when it will become a legend, a memory, and its place be taken by its more vigorous and hardy rivals. All ancient and modern history illustrates the same point. The same law that governed the passing away of the Egyptians, the Babylonians, the Assyrians, the Medes and Persians, the Greeks, the Romans, the Moors, the Turks, is at work to-day, and is so clearly illustrated in the history of modern Spain and France. Spain has long since passed the zenith, and is sinking as so many of its predecessors have sunk before; while France is still hovering in the period of stagnation, and will sink, like all the others, unless some great internal moral upheaval should start her on the advance again.

There is no avoiding the issue; to struggle and advance or stagnate and die. The law of evolution applies as clearly and distinctly to nations as to individuals and species; and any nation that wishes to live must go into the struggle with all its might, and provide itself with every possible safeguard and weapon of defense.

The struggle may be peaceful and commercial only; but we must be prepared, if necessary, to meet force with force, for human nature changes little from age to age, and the days of war have not yet passed away.

It is face to face with this great question that the Spanish war has brought us—a question so infinitely greater than the war itself. In fact, the war itself was merely the crystallizing drop that precipitated the result of more than a century's growth and evolution. The same result would have been reached without it, though not so soon or so rapidly. That the most populous, prosperous, energetic, vigorous, and richest of all civilized nations should remain to itself, and refuse forever to take its part in the affairs of the world, was an evolutionary impossibility. Such action is only possible when the vigor and energy of the race have departed; and the result is only too well illustrated by the experiment of isolation tried by the Chinese some thousands of years ago, and persisted in to the present time.

We are in the world to work out our destiny, and may as well face the fact; and it behooves us to take all possible measures for our advancement and security, or our keen-witted, active, and powerful rivals will outrun us in the race and leave us stranded in stagnation, to sink as so many nations have done before.

Admitting, then, the necessity for action, to equip ourselves to maintain worthily our part in the struggle, let us take a short view of a few of the most vital and urgent questions for national advancement and defense that present themselves to the mind. Three only will be considered here. These are the maintenance of an adequate navy, the construction of an inter-oceanic canal, and the laying of a trans-Pacific cable. Of the first little will be said, as its necessity is recognized almost universally, both in and out of Congress, though a few words on its value and necessity may not be untimely.

The only aids needed by American commerce to compete with and lead the world are assured protection, easy and prompt communication, and a free field. Assured protection can only be given by a firm Administration, backed by a navy strong enough to enforce, if necessary, its just demands. A strong navy not only secures protection and extension of commerce, but is the greatest known guarantee of peace. A few millions of dollars judiciously spent in battleships previous to 1898 would have gained our end without bloodshed; and the country would have been spared the hundreds of millions the war actually cost, not to mention the hundreds of brave men. But the question of the maintenance of an adequate navy need not be dwelt on further, for the necessity is almost universally admitted, as remarked above, and the Congresses continue to make very wise and liberal provision for the maintenance and increase of the fleet.

We may take for granted, then, that the navy, which is the nation's insurance against war and the protector of commerce, will continue to grow and be provided for, commensurate with the nation's needs; and that we will be properly provided with this great bulwark of defense, and weapon of offense in our struggle for supremacy with the other great nations of the world. Let us see how the navy can be made most effective, and attain its utmost development and usefulness by winning the supremacy in the arts, in commerce and in civilization, as well as in war.

Examining the question from this point of view, we see at once two great lacks both in our means of defense, and in our means of extending and strengthening our influence abroad. For sure defense, both of our own coast and of our island possessions, it is absolutely necessary for the fleet to have perfect freedom of movement to all parts of our coasts. To carry out any design, both for the protection and extension of our influence in our far distant possessions, it is necessary to have absolutely sure communication between our fleets and the seat of government.

The former of these objects can only be attained by the construction of a national inter-oceanic canal, and the latter by a National Pacific Cable.

It seems to be only a question of a short time when the first of these two great projects, which will add so much to the National defense—not to mention the great extension of commerce—will be undertaken. There seems to be a practical agreement in both Houses of Congress, both as to the necessity and as to the manner of undertaking this great work.

In the case of the cable, however, which is equally important for both national and commercial reasons, the situation is different; and the prospects of its being undertaken at an early day seem more than doubtful, because Congress is undecided whether it shall be a private or a national undertaking. The necessity and importance of a cable of some kind being laid seem not to be questioned by any one.

The Senate says that it shall be a government-owned and controlled cable, while the House says it shall be a private cable with a large government subsidy. And so the controversy continues and threatens to defeat the great project which is so necessary to the national development and defense.

Leaving aside the commercial advantages to the country of a Pacific cable, which are universally admitted, a few remarks on the military and strategical side of the question should convince any fair mind of the advantages of a *national* cable, if we wish to retain our supremacy in our island possessions, and extend our influence in the East.

The secret of a great success of any kind is thorough, careful and efficient preparation. Great crises and struggles do not come in a moment, but are the results and developments of long preceding events, and when the emergency comes, that nation will be victorious which has had the wisdom and foresight to prepare for it, and prepare efficiently. It is only thus that the necessary force and power can be promptly and efficiently brought to bear at the right time and place to attain the desired end of success. It is too late to begin preparation after the emergency has actually arisen, unless we deliberately set ourselves to invite disaster and defeat. Improvised methods in the face of danger are only the makeshifts of previous culpable inefficiency and carelessness. To be strong and to attain our ends, we must be ready and prepared; and when the emergency has actually arisen, and the time comes to strike the blow, strike it with all our might in the full confidence of our efficient preparation to attain the desired end. And, in almost all cases, the mere fact of full preparation to act, and of having power enough to act efficiently, will be sufficient to obtain the object in view, and will render actual conflict unnecessary.

In all questions affecting the Philippines themselves, or the East in general, the Philippines must, of necessity, be the base of these necessary preparations; and in a country so distantly situated from the seat of government, no preparation can be efficient without quick, sure and secret communication. Quickness of communication can be established by the laying of any kind of cable, whether private or national. But surety and secrecy can only be attained by a cable owned, controlled and worked by the government itself, by its own agents. A very cursory review of the book published in his own defense by the Spanish Admiral, Cervera, since the close of the war, will show how utterly impossible it is, even in time of war with strict censorship, to maintain secrecy with private cables. In spite of all our efforts to isolate Cuba, and suppress all despatches regarding the movements of our ships, we are astonished to find how minutely General Blanco and Admiral Cervera were informed of the movements of our ships and squadrons, even on our own coasts.

And this was in time of war, when all efforts possible were made to maintain secrecy. What would it be in time of peace, with no censorship, if great preparations were on hand that it was vitally necessary to maintain secret, and a knowledge of which to our rival would be equivalent to complete frustration of all our plans? And let it be always remembered that the time of preparation is *always* in time of peace, before hostilities actually begin. When war is actually declared the time to prepare is past, and the time to act has come; and the action will be just so swift and sure as the preparation has been careful and perfect.

Then, too, if the crisis does not come to actual war, it will be due solely to the state of preparation our adversaries will find us in to maintain our rights—a preparation that will have been carried on in time of peace, when the whole host of news-gatherers of the world will have been hot on the trail for scare head-lines.

What private cable company can and will guarantee the necessary surety and secrecy? or, having guaranteed it, can maintain it? The cable history of the late Spanish war says none. The only guarantee is a cable laid and owned by the government itself, and operated by its own officials, and these officials must be Americans first, last, and all the time.

From a military point of view, this question of the nationality of the operators is most important. No foreigner or alien of any description should be allowed to have any connection with the line in any capacity whatever. Its direction and operation should be American pure and simple; or betrayal of trust surely will follow. A glance at the conditions imposed by England on all English cable companies shows how jealously she guards this point of nationality of employees. No English cable, whether government or subsidized, can employ any operators other than English subjects.

Turning now to the few American-owned cable lines already in existence, and on whom no condition as to nationality of operators were imposed, we notice a very different state of affairs. We find staffs largely made up of foreigners, especially Englishmen; and these lines, politically speaking, constitute, in fact, hardly more than annexes and extensions of the great British system that to-day dominates the world, and puts all important cable news, whether commercial, military or political, through London first, and to its intended destination afterwards.

Such is the condition of affairs now, and in the case of this proposed Pacific cable, there will be simply an extension of the same system if the cable is laid as a private enterprise. In House Bill No. 2980 of the present Congress—the bill drawn in the interest of private ownership—we find no mention of any restriction whatever as to nationality of employees. Should this bill become a law, experience teaches us that the new cable, under private ownership, will become merely a still further extension of the British system; and our most important and secret instructions to our fleets and armies in the far East will be at the mercy of, and subject to, the betrayal or perversion of alien operators.

This is a point that seems to have been overlooked in the entire cable discussion; and it is one of such vital importance that it cannot be put in too clear and urgent a light.

One other great military advantage of a national over a private cable, which seems to have been overlooked, is the possession by the government of properly equipped and manned cable ships. In the conflicts of the future, as clearly foreshadowed in the late Spanish war, the cable and cable ship is destined to play a partly hardly secondary to that of the army and fleet. The cutting or laying of cables will progress side by side with the military and naval operations; and the nation that finds itself deprived of the means of gaining its own information, and interrupting that of the enemy, will find itself at a decided disadvantage. Sure knowledge and quick communication more than double the values of armies and fleets, and nothing so demoralizes an enemy as to find himself cut off from knowledge, not only of his adversary, but of his own forces.

All this was clearly indicated in the Spanish war, and this lead will be more and more followed in all future conflicts. England alone, of all the great powers, is already fully equipped in this direction; but all the other leading European powers are beginning to see the danger, and their brightest minds are urging them to repair the lack, and construct and complete their lines of cable defense, as necessary for ultimate self-preservation.

It may be taken as an axiom in future wars between nations with outlying possessions, that a cable war will go on side by side with the military and naval operations; and that nation which has failed to provide itself with cables and cable-laying and cutting appliances will be worsted. Therefore, since we, by annexing Porto Rico, Hawaii, Guam, Tutuila, and the Philippines, have joined the list of nations with far-distant island possessions, cables and cable ships and appliances have become absolute necessities, unless we wish to invite defeat and humiliation in the first conflict.

And that full benefit shall accrue from these aids to the national defense and means of offense, they should, beyond all question of a doubt, belong to the government. It is only in this way that they can be surely and absolutely controlled, and be ready at all times for national use; that the ships will be ready at all times to go silently and secretly on a mission of destruction, to the confusion of an enemy, or on one of creation that may increase five-fold the value of our fleet and army.

The inefficiency and cost of improvised measures to attain the same end was only too well illustrated in our continuous and ineffectual effort to isolate Cuba in the late war. A single properly equipped and manned cable steamer, under the American flag, would have accomplished the object in a couple of weeks, and would have done it effectually.

The little reliance that can be placed on private corporations in like emergencies was also only too well illustrated in the same war.

There was, on the eve of war, one properly equipped American-owned cable ship. This was the cable ship Relay, owned by the Central and South American Telegraph Cable Company, a company incorporated under the laws of the State of New York. This ship was stationed on the west coast of South America, where the main lines of this company are laid. In the records of the State Department, we find a report from the United States Consul at Callao, Peru, dated April 18, 1898, reporting a sale of the foreign-built *American* cable steamer Relay, on April 14, 1898, to two British subjects, on behalf of the Central and South American Telegraph Cable Company, for $260,000, and notifying the Department of the paying off of the crew and change of flag. Further on, we find another consular report from Callao, dated October 29, 1898, reporting the sale back of the same steamer Relay, on October 13, 1898, by the same two British subjects, to the same Central and South American Telegraph Cable Company, for the same sum of $260,000.

These facts speak plainly for themselves. At a time when the possession and use of a cable ship were vital to the interests of the country, the private owners of the only ship available, to protect the capital and dividends on their private-owned cable, made a transfer of the ship to the British flag just as war was inevitable, and transferred back again after hostilities closed, removing it from the power of the government to take and use the ship in the time of its need.

With such experience, it would seem almost suicidal, from both a military and a political point of view, to trust private corporations with interests vital to the welfare of the nation; and the government owes it to itself, and to the people for whose protection it exists, to provide for its own defense and security.

Summing up all the foregoing arguments in a few words, it may be said that we, as a nation, are following the inevitable law of evolution. We have left behind our swaddling clothes, and have entered the field of competition with the other great nations of the world. We are in the struggle for political supremacy and commercial pre-eminence, whether we wish it or not, and must advance always; for stopping means stagnation or decay. In the struggle for life with energetic, vigorous and powerful rivals, we must equip ourselves at all points, or be pushed out of the race and swept aside by our more vigorous adversaries.

Recent experience has taught us that cables and cable ships will in future wars be called on to play a rôle scarcely inferior to that of naval and military forces themselves, not to mention their great peaceful rôle in the struggle for commercial supremacy. Experience has also taught us that private enterprise cannot be relied on in times of emergency to sacrifice its own financial interests for the public good, and that the government must rely on and protect itself. The universal experience of all times and ages has taught us the absolute necessity of prompt and reliable information to a nation's forces for a successful issue in any struggle. That only with prompt and sure knowledge can the deciding blow be struck at the right time and place; and, with that, the value of a nation's forces is increased many fold. Only with a cable can such knowledge be attained in distant lands and seas. Only with a government-owned and controlled cable can the necessary secrecy and certainty be assured for efficient preparation and successful action. And, finally, only with government-owned, equipped and manned cable ships can the government be assured at all times of the means of cutting, laying and repairing cables in the times of its need; and this ability to cut, lay and repair cables in time of war is destined to be one of the great deciding features in all future colonial wars.

Therefore, if we wish to secure ourselves against all eventualities, and be fully equipped to take our part successfully in the struggle of races that the inevitable laws of evolution force us to enter, let us not only fortify our ports, build fleets and equip armies, but let us, by all means, prepare the way to render these fleets and armies efficient, and capable of their utmost usefulness, by supplying them with the safe, sure and prompt information, so necessary to any successful undertaking. The only way to attain this end, with certainty and success, is for the government to lay and operate its own cables, and to construct, equip and man its own cable ships; and the beginning of this great work cannot be made too soon.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVAL BATTLE OF MANILA.

By LIEUTENANT JOHN M. ELLICOTT, U. S. Navy.

It will be the writer's endeavor in the present article to present an accurate narrative of the Battle of Manila from the standpoint of a participant and eye-witness and from details gleaned by unremitting inquiry since the battle. The magnitude of the strategic and political results can scarcely now be predicted.

In February, 1898, the United States squadron in Asiatic waters consisted of the first-rate protected cruiser Olympia, flagship of Commodore George Dewey, the second-rate protected cruisers Raleigh and Boston, the gunboats Concord and Petrel, and the old paddle-wheel gunboat Monocacy. The Olympia, having been on the station three years, was slated to exchange places with the second-rate protected cruiser Baltimore, then flagship of the Pacific station, in order that the former might finally reach the Mare Island Navy Yard for overhauling. The Baltimore was at this time in Honolulu.

The strained relations between the United States and Spain over the condition of affairs in Cuba did not seem likely to lead to war, so the vessels of the Asiatic Squadron were in various Japanese and Chinese ports, engaged in the numerous peace missions on a foreign station, when, on the 15th of February, the whole world was horrified by the blowing up of the battleship Maine in Havana harbor. Nations stood aghast, and the war cloud formed with the rapidity of a thunder storm at the close of a sultry day. The Asiatic Squadron was almost immediately mobilized at Hong Kong. The Olympia was directed to remain on the station and the Baltimore was ordered out from Honolulu as a reinforcement. The Monocacy, being too antique and infirm to be of service in battle, was left at Shanghai; one-third of her crew and half of her officers being ordered to join the squadron at Hong Kong.

The revenue cutter Hugh McCulloch, *en route* to our Pacific coast by way of the Mediterranean and Asia, was directed to join the squadron at Hong Kong as a despatch vessel.

At that port every effort was made to put the vessels in fighting trim. Machinery was overhauled, hulls cleaned, bunkers filled and the ships painted a dark slate color. The British freight steamer Nanshan and passenger steamer Zafiro were purchased, the former being loaded with coal and the latter with coal and provisions.

The squadron, however, lacked a war supply of ammunition. To remedy this the old wooden corvette Mohican was loaded with powder and shell at San Francisco and rushed to Honolulu, where her precious cargo was transferred to the Baltimore.

The latter's journey to Asiatic waters was a precarious one, for the situation had become so critical that war might have been declared at any moment, in which event it would have been a telling stroke of strategy for the Spanish squadron in the Philippines to intercept this single cruiser in overwhelming numbers and capture or sink her with her invaluable munitions of war. When she arrived in Yokohama war seemed but a question of hours, and in the remainder of her journey she had to pass close to the Spanish strongholds. Anxiety in the squadron had therefore reached exciting intensity when, on the morning of April 22, she appeared safely in the harbor of Hong Kong still clothed in her peace garb of white. Arrangements had already been made to dock and coal her, so that on the morning of the 24th she took her place in the squadron, cleaned, coaled and in war-paint.

There had not been a moment to spare, for war had been declared on the 23d, but the fact was not generally known till the next day, when Great Britain's proclamation of neutrality was published and the United States squadron requested to leave port in twenty-four hours.

Some repairs to the Raleigh's machinery were incomplete, the needed parts being in a machine shop on shore, but, more important still, the U. S. Consul at Manila was expected to arrive in Hong Kong on an overdue steamer from the Philippines with important information concerning the positions and strength of the enemy. The Boston, Concord and Petrel, with the McCulloch and transports, were therefore sent to a rendezvous in Mirs Bay, an inlet on the China coast some thirty miles above Hong Kong, while the rest of the squadron remained to the limit of their day of grace. This did not avail, however, for the morning of the 25th brought neither consul nor machinery, but it brought Commodore Dewey's instructions to proceed to the Philippines and capture or destroy the enemy's fleet.

At 9 o'clock on the morning of that day the flagship, Baltimore and Raleigh weighed anchor, formed column and stood out of Hong Kong harbor, their bands playing the "Star-Spangled Banner." The sight of that intrepid squadron, seven thousand miles from all support, the ports of the world closed against it in cold neutrality, going forth undaunted to grapple with a remorseless foe in his own stronghold was too much for our Anglo-Saxon kinsmen to look upon unmoved. British sailors clambered into the rigging of their ships; British soldiers crowded to the edge of the cliffs, and cheer after cheer went after the gray, receding ships until they disappeared from sight, and the last door of hospitality was closed behind them. Then all the world waited and wondered. The most intensely peace-loving people on earth had been aroused to deadly combat. A nation which had not struck a blow in anger for a third of a century was about to meet in mortal struggle another inured to continual strife. Great modern engines of destruction were about to be tested for the first time by western races. Around the coasts of Asia, as upon the benches of an amphitheater, all nations of the earth were grouped in expectation, as the first contestant stepped forth into the arena and advanced upon his adversary.

All the squadron was assembled in Mirs Bay by noon. The afternoon was spent distributing the Baltimore's cargo of ammunition among the other ships. That night all lights in the ships were concealed by battle-shutters in the air-ports, darkening the vessels so completely that one could not be seen from another, and a sharp lookout was kept for the enemy's vessels. Next day many spars, chests, hatch-covers and other articles of wood which could be splintered by shells were sent to the transports. Twenty-four hours later a tug arrived from Hong Kong bringing the Raleigh's repaired machinery and U. S. Consul Williams.

The squadron sailed immediately (27th), shaping a direct course for the Island of Luzon. The order of cruising was in two columns abreast. The Olympia, Baltimore, Raleigh, Petrel, Concord and Boston, in the order named composing the left-hand column, and the McCulloch, Nanshan and Zafiro the right-hand one. The fighting characteristics of the squadron are given in the following table:

Ships.	Displacement.	8″ guns.	6″ guns.	5″ R. F. G.	Complement.	Broadside in lbs.	Torpedoes.
Olympia....	5870	4	..	10	412	1250	6
Baltimore...	4413	4	6	..	386	800	..
Raleigh.....	3213	..	1	10	314	350	4
Boston	3000	2	6	..	278	800	..
Concord	1710	..	6	..	195	300	..
Petrel	892	..	4	..	122	200	..
McCulloch ..	1280	..	..	..	100 (est.)	12	..
Total.....	20,378	10	23	20	1807	3712	10

These vessels were also well armed with all calibers of secondary battery guns. The McCulloch's boilers and engines were above the water-line and entirely unprotected, so that she was unfit for the fighting line.

The Spanish fleet in the Philippine Islands, as given in their official register, was as follows:

Ships.	Displacement.	16 cm. guns.	15 cm. guns.	12 cm. guns.	9 to 7 cm. guns.	Broadside in lbs.	Complement.	Torpedoes.
Reina Cristina	3520	6	..	..	5	440	409	5
Castilla..................	3260	..	4	2	6	290	438	2
Isla de Cuba	1045	..	..	4	2	116	189	3
Isla de Luzon	1045	..	..	4	2	126	189	3
Don Juan de Austria.......	1159	..	..	4	2	120	209	2
Don Antonio de Ulloa	1160	..	..	4	4	130	190	2
Velasco..................	1152	..	3	..	2	212	175	..
Elcano	560	..	..	3	..	110	135	1
General Lezo.............	520	..	..	2	1	70	135	..
Marques del Duero	500	1	..	2	..	190	114	..
Villalobos	300	..	..	..	1	6	65	..
Quiros..........	300	..	..	..	2	6	59	..
Argos	508	..	..	..	1	12	108	..
6 gunboats (200 tons)	1200	..	..	..	6	90	252	..
7 gunboats (150 tons)	1050	..	..	..	7	105	294	..
9 gunboats (50 tons)	450	..	..	..	..	..	225	..
Manila (transport)........	1900	..	..	..	3	12	97	..
Cebu (transport)..........	532	..	..	..	1	6	88	..
General Alava (transport) .	532	..	..	..	2	6	84	..
Total................	20,693	7	7	25	47	2047	3455	18

Consul Williams brought information that the greater part of the above fleet, some smaller gunboats excepted, was mobilized in Manila Bay; that there were three or more batteries along the water front of the city, two on Sangley Point protecting the navy yard at Cavite, one or more at Mariveles, two or more on Corregidor and Caballo Islands and one or more on the south shore of the entrance to the bay, all of six- to nine-inch caliber. Mr. Williams had also been credibly informed that the customary entrance to the bay between Corregidor Island and Mariveles, and the waters in the vicinity of Cavite, had been extensively mined. He further stated that a large merchant transport, the Isla de Mindanao, of the Compania Transatlantica, arrived the day before his departure, laden with munitions of war, including coast guns, automobile torpedoes and submarine mines, the latter intended for the larger entrance to the bay south of Corregidor.

Assuming, then, that each shore battery contained at least two guns, which afterwards proved to be an under estimate, and that the Spanish Admiral was going to make his stand in Manila Bay, Commodore Dewey had to expect to draw the fire of at least five batteries, of ten 6-inch guns or larger, whichever entrance to the bay he chose and whether he found the Spanish fleet at Manila or Cavite. Since a commander, when entering a theater of operations, must look to the contingency of the whole enemy's force being combined to the best advantage against him, we may now tabulate the elements of the opposing forces as they must have presented themselves to Commodore Dewey when he started for Manila.

	United States.	Spanish.
Vessels . . .	5 cruisers. 2 gunboats.	7 cruisers. 6 gunboats. 25 mosquito vessels.
	Armed Tonnage, 20,438.	20,693.
	Main B Guns, 55.	49 or more.
	Broadside, 3700 lbs.	3000 lbs.
	Men afloat, 1807.	3455.
	Torpedoes, 10.	18.

We must add to this the probability that the entrances to the bay and the approaches to Manila and Cavite were strewn with submarine mines. Hence, assuming that the Spaniards were fairly good marksmen and that the best dispositions would be made of their material, it must be conceded that the apparent odds were not in favor of the United States squadron.

On the afternoon of the first day out from Mirs Bay all hands were called to muster on each ship and the following proclamation of the Governor-General of the Philippines was read:

"SPANIARDS :—Between Spain and the United States of North America hostilities have broken out.

"The moment has arrived to prove to the world that we possess the spirit to conquer those who, pretending to be loyal friends, take advantage of our misfortunes and abuse our hospitality, using means which civilized nations count unworthy and disreputable.

"The North American people, constituted of all the social excrescences, have exhausted our patience and provoked war with their perfidious machinations, with their acts of treachery, with their outrages against the law of nations and international conventions.

"The struggle will be short and decisive. The God of Victories will give us one as brilliant and complete as the righteousness and justice of our cause demand. Spain, which counts upon the sympathies of all the nations, will emerge triumphantly from this new test, humiliating and blasting the adventurers from those States that, without cohesion and without a history, offer to humanity only infamous traditions and the ungrateful spectacle of Chambers, in which appear united insolence and defamation, cowardice and cynicism.

"A squadron manned by foreigners, possessing neither instruction nor discipline, is preparing to come to this archipelago with the ruffianly intention of robbing us of all that means life, honor, and liberty. Pretending to be inspired by a courage of which they are incapable, the North American seamen undertake as an enterprise capable of realization, the substitution of Protestantism for the Catholic religion you profess, to treat you as tribes refractory to civilization, to take possession of your riches as if they were unacquainted with the rights of property, and to kidnap those persons whom they consider useful to man their ships or to be exploited in agricultural or industrial labor.

"Vain designs! Ridiculous boastings!

"Your indomitable bravery will suffice to frustrate the attempt to carry them into realization. You will not allow the faith you profess to be made a mock of; impious hands to be placed on the temple of the true God; the images you adore to be thrown down by unbelief. The aggressors shall not profane the tombs of your fathers, they shall not gratify their lustful passions at the cost of your wives' and daughters' honor, or appropriate the property your industry has accumulated as a provision for your old age. No, they shall not perpetrate any of the crimes inspired by their wickedness and covetousness, because your valor and patriotism will suffice to punish and abase the people that, claiming to be civilized and cultivated, have exterminated the natives of North America, instead of bringing to them the life of civilization and of progress.

"Philippinos, prepare for the struggle and, united under the glorious Spanish flag, which is ever covered with laurels, let us fight with the conviction that victory will crown our efforts, and to the calls of our enemies let us oppose with the decision of the Christian and the patriot, the cry of 'Viva Espana.'

"Your General,

"BASILIO AUGUSTIN DAVILA."

"*Manila, 23d April, 1898.*

Immediately after the reading of this remarkable document the crews were informed that they were bound for the Philippines to "capture or destroy the Spanish fleet." Probably no such cheers have ever before floated over the China Sea as then went up from each ship of the squadron, assuring each commander that he need not count alone on the skill and obedience, but upon the eagerness and enthusiasm of the men behind the guns.

The run across the China Sea was made as directly and with as little attempted concealment as if on a peace mission. Lights were carried at night and electric signals freely exchanged; but gruesome preparations were going on within each ship. Anchor chains were hung about exposed gun positions and wound around ammunition hoists; splinter nets were spread under boats; bulkheads, gratings and wooden chests were thrown overboard; furniture was struck below protective decks; surgical instruments were overhauled and hundreds of yards of bandaging disinfected. The sea was strewn for fifty leagues with jettisoned woodwork unfit to carry into battle.

Leaving this squadron seeking its adversary with such grim directness, let us see what the Spaniards were doing.

A war board had been in session at Manila for two months devising means for defense. It directed the erection of batteries at the entrances to Manila and Subig Bays, the laying of mines and the mobilization of the fleet, but its members were fatally at variance as to where the fleet should make a stand. The commandant of the land forces at Manila wanted it in front of the city supported by the water-front batteries. The Spanish Admiral wished to go to Subig Bay. The idea of utilizing the tactical advantages of some of the many channels around the other islands, maintaining a "fleet in being," and causing the American squadron to fritter away its scanty supply of coal and provisions in vain attempts to strike a crushing blow, does not seem to have been entertained.

Manila Bay is a vast pocket in the west side of the island of Luzon, twenty-odd miles deep and nearly as many wide, with an entrance ten miles across, divided by the island of Corregidor into channels known as Boca Chica and Boca Grande, two miles and six miles wide respectively. Subig Bay, thirty miles farther north, is almost exactly similar but much smaller.

On the night of the 25th of April, Admiral Montojo took his squadron to Subig Bay with a view to making his stand there. He found four 15 cm. guns (and ammunition) landed on the island at the entrance, but which could by no possible effort be emplaced within a month, so remaining there only long enough to repair the Castilla, which had developed a serious leak around her stern tube, he returned to Manila Bay on the evening of April 29 and anchored his squadron off Cavite Arsenal, where he prepared for battle. By that date the land defenses of Manila Bay, though not complete, were formidable. Guarding the Boca Chica were three 8-inch Armstrong muzzle-loading rifles on Corregidor Island, three 7-inch muzzle-loading rifles on Punta Gorda and two 16-cm. converted breech-loading rifles on Punta Lasisi.

Guarding the Boca Grande were three 6-inch Armstrong breech-loading rifles on Caballo Island, three 16-cm. muzzle-loading rifles near Punta Restinga and three 12-cm. breech-loading rifles on El Fraile Rock. The last-named guns were taken from the gunboat Lezo and those on Caballo from the cruiser Velasco, which were undergoing repairs at Cavite, and so far from ready that all hope of getting them into service for the war had been abandoned.

The Don Antonio de Ulloa was unfit to steam. This vessel was therefore moored head and stern just inside Sangley Point, over which she could readily fire, and her inshore (port) battery was removed and emplaced on shore about a mile and a half westward, at Canacao. One of these two guns was ready for service and used on the first of May.

There was also on Sangley Point a modern fortress of masonry and earth in which were mounted two 15 cm. Ordonez breech-loading rifles. As the batteries at Manila do not enter seriously into this narrative they will not be described.

Mines are said to have been laid in the Boca Grande, off Cavite, and to N.Ed. of St. Nicholas shoal.

Admiral Montojo anchored his squadron across Bakoor Bay in a N.Ely and S.Wly line somewhat curved back toward Bakoor; his left, prolonged by the Ulloa, resting on Sangley Point and having the protection of Sangley and Canacao batteries. Besides being in shoal water, it was further protected from being turned by a line of iron lighters loaded with sand and moored together head and stern, extending in prolongation of Sangley Point, screening the ships on the left wing but in no way masking their fire. From Sangley Point to the N.Ed. the Spanish ships were disposed as follows: Don Antonio de Ulloa, Castilla, Reina Cristina (flagship), Don Juan de Austria, Isla de Cuba, Isla de Luzon. A little inside and abreast the others lay the Marques del Duero, and possibly the Argos, but there are some indications that the latter remained at the arsenal, as did the Velasco, Lezo and transport Manila. A small armed guard was kept on each of these latter vessels and their crews distributed among the other ships, the greater number going to the Reina Cristina. The ships were cleared for action, light spars and boats sent ashore, etc., but many minor items were left to the last moment, so that the squadron went into battle without unshipping awning stanchions, hatch canopies, or gangway ladders, and, excepting her gun sponsons, the Castilla was still painted white.

Two 6-inch Armstrong muzzle-loading rifles mounted on the ramparts of Fort San Felipe in Cavite Arsenal could fire over the squadron at the enemy.

By the Spanish disposition for battle, the United States squadron would have to endure the fire of three 16-cm., three 6-inch and three 12-cm. guns, a broadside of 725 pounds of metal, in entering the Boca Grande, or of five 8-inch, two 7-inch and two 16-cm. (898 pounds) in Boca Chica, beside running the risk of submarine mines at three different points in the approach to Cavite, and would then have to fight eight or nine vessels and three shore batteries, mounting in the aggregate 36 guns and throwing a broadside of 1,800 pounds of metal, or, more briefly, Commodore Dewey had actually to encounter 45 guns throwing 2,525 pounds of metal. The rapidity with which he got in touch with his adversary prevented the emplacement of several more guns at Sangley and Canacao and the mobilization of the remaining gunboats of the Spanish fleet.

On the morning of April 30, the United States squadron reached the coast of Luzon near Cape Bolinao, stood close in under the green, mountainous bluffs and coasted southward, keeping a sharp lookout for the enemy. The Boston and Concord were sent ahead at full speed as scouts and to search Subig Bay. Later in the day the Baltimore was also sent ahead to Subig, where, upon arriving, she found the other two ships coming out, they having skirted all round the bay and seen nothing of the enemy. It is interesting to note that twenty-four hours earlier they would have found there nearly the whole Spanish fleet. The Baltimore stopped a Spanish schooner with a shot across her bow, but her crew professed the densest ignorance of the whereabouts of a single Spanish naval vessel.

It was nearly sunset when the squadron reassembled at the entrance to Subig Bay. Here Commodore Dewey stopped and called his captains on board the flagship to receive what proved to be their final instructions before the battle. It was a deeply impressive scene: these nine ships, dark as the clouds of a gathering storm, resting against a background of bright green hills and graceful waving palms, and illumined by the golden radiance of the setting sun; over them sweeping the light land breeze, wafting the perfume of fragrant tropical flowers, and from their decks the notes of their bands rising in evening concert as they played, by instinctive agreement, "There'll be a hot time in the old town to-night." The stage had been set, the orchestras were playing the overture and the curtain was about to rise upon a new and terrible international tragedy.

The captains soon returned from their conference and once more the squadron was put in motion, but now the McCulloch, Nanshan and Zafiro fell directly astern of the Boston, so that there was formed a single column, flagship leading, transports in the rear. It was quickly known, almost without the telling, that Commodore Dewey was going to run past the forts into Manila Bay that night and engage the enemy as soon as found in the morning. Only a single white light at the stern of each ship was to be shown, screened in all directions but astern, to guide the next ship behind.

The night was ideal for the enterprise. The little light needed to find the entrance to the bay was furnished by a young moon which would set soon after midnight. After it had served its purpose, and the dark outlines of Corregidor Island had been discerned, a screen of passing clouds hid the moon almost constantly from view, giving the benefit of its diffused light but seldom permitting a sheen upon the water.

Early in the evening the crews were called to quarters, guns cast loose and loaded, ready ammunition ranged on deck and every preparation made for battle. Then officers and men not actually on watch were allowed to sleep on their arms till the moment for action. Most of them were still standing about the decks in low-conversing groups, however, when, at 10.40, the word was quietly passed around to stand to the guns. The squadron was approaching the Boca Grande. The mountainous headlands at the entrance to the bay were looming up on either hand, occasionally thrown out in bold relief by sluggish, copper-colored lightning from thunder clouds behind them. A darker, nearer object lay between like a huge, ill-moulded grave. This was Corregidor Island, the armed sentinel of the bay. There was a light-house upon this island and also upon its little neighbor, Caballo, but neither was lighted. Straight on the squadron steamed, now at the moderate speed of 8 knots, as confidently as if through a lighted channel. American officers were guiding it, and no hired pilot. It is probable that few of the navigators who conned those ships into Manila Bay that night had ever been there even in the broad light of day, but United States naval officers are educated and trained for such emergencies.

Nearer and nearer loomed Corregidor as these ghost-like ships stole on undiscovered. Even to each other they were scarcely visible; each seemed alone save for a little white light ahead, always leading onward. Guns were silently trained ever toward the dark cliffs, which were constantly searched with night-glasses. At last the island was abeam. Men held their breath and hearts almost stood still. Where were the Spanish lookouts? where their picket boats? where their terrible mines? The flagship ran boldly close up to El Fraile Rock in order to shape from it a good course into the bay, little suspecting that a battery had been erected upon it.

Midnight came and went and the hope began to form that the squadron would get into Manila Bay undetected, when suddenly a light was displayed, apparently on a vessel in Mariveles Bay, then a bright light flared up on the south shore near Punta Restinga. The flagship, in turning at El Fraile Rock, had disclosed her stern light toward Restinga, and at the same moment soot in the McCulloch's smokestack caught fire. The signal at Restinga Point was answered by a bright rocket on Corregidor and a flare-up light on El Fraile. Then Restinga battery shot out a sharp tongue of flame, followed by a dull report, and the rising notes of the first screaming shell came nearer and nearer till it passed with a fierce hiss high over the Raleigh and plunged in the water beyond. Another followed quickly, falling just astern of the Baltimore. Restinga battery fired no more but now Fraile opened. The Raleigh and some of the rear vessels returned the fire; one shell, as afterward discovered, bursting directly in the midst of this battery and silencing it after it had fired but three times. Caballo and Corregidor remained silent. It is probable that at a distance of three miles the passing ships were wholly invisible except when discovered by their stern lights.

It was twelve minutes past midnight when the first gun was fired, and in half an hour the whole squadron had passed out of range unscathed into the still waters of Manila Bay. Twenty miles away the sky was illumined by the lights of the city.

Excellent navigation, cool judgment and daring audacity had foiled three batteries and knocked off 725 pounds from the enemy's available broadside.

Concealment was no longer necessary. Bright rows of electric signal lights, red and white, were flashed from ship to ship, until the chagrined and astounded Spaniards on Corregidor must have thought the Americans were holding a water carnival. It was only the flagship setting the speed at four knots for the remainder of the night, and calling the McCulloch and transports up on her port beam.

The lights died out, crews were allowed to sleep at their guns, and the squadron continued its silent journey towards its slumbering adversaries.

That the Americans would dare to run the batteries, pass over probable mine fields and be able to find their way into Manila Bay in the dead of night, and that on the first night of their arrival on the coast, without even a casual reconnoissance to take note of these difficulties, seemed never to have entered the Spanish mind. The Spaniards had exact information by cable from Hong Kong of the sailing of the American force from Mirs Bay, and were promptly informed from Bolinao and Subig of its arrival on the coast. Nevertheless Admiral Montojo seemed to think he had still a few days' grace, for among his captured effects were found an order for his ships to be ready for a grand inspection on the morning of May 1. Fires were banked on the ships and many officers were sleeping ashore at the Arsenal with their families when the dull boom of the guns at Corregidor gave warning that the enemy was creeping upon them in the darkness.

It was two o'clock in the morning when Admiral Montojo was informed by telegraph that the whole American squadron was in the bay. Steam was ordered at once, officers and men were turned from their slumber and their families and hurried aboard ship, many of them never to return alive, and every preparation was made for battle.

The night was sultry; the light breeze of the evening died out; the sky gradually cleared. In the early dawn Manila Bay was like a sheet of silver. Toward five o'clock a forest of masts became indistinctly visible to the Americans right ahead, and behind them the white houses of Manila. Close scrutiny showed only merchant vessels, but almost at the same time, off to the right, was seen a number of white buildings on a low point, and beyond them a line of dark gray objects on the water. The Olympia immediately headed straight for these, followed by the squadron in column. They quickly developed into the Spanish ships off their arsenal at Cavite; one of them, the Castilla, being white, showing out with great distinctness. The black merchant transport Isla de Mindanao lay in prolongation of the line to N.Ed.

Only holding his course toward the enemy's ships long enough to make out their number and disposition, Commodore Dewey headed again toward Manila, and at 5.05 hoisted the signal "prepare for general action."

Everybody was already up, all peering through the mist of the morning. On some ships a little coffee had been served, but, on all, the men were without breakfast; galley fires remaining extinguished. When that awe-inspiring signal went up to the flagship's yardarm the Stars and Stripes broke from every staff and masthead in the squadron. Twenty-six American flags floated in deadly challenge before the incredulous eyes of awaking Manila. The McCulloch and transports were then left in the middle of the bay and the fighting column turned to starboard, sweeping slowly past the city of Manila as if passing in review, and headed directly for the Spanish fleet. At the same time the Spanish colors were displayed at the gaffs and flagstaffs of the enemy's ships. As most of these had sent down their topmasts and left them ashore, no flags flew at their mastheads except on the Castilla, and the Admiral's flag on the Cristina. Almost immediately the batteries at Cavite and Manila opened fire, but their shells fell short and were ignored. At 5.20 the Spanish ships opened, but these shells, too, fell short, and the American squadron stood on without replying.

At last, just as the sun of May 1 rose over the hills and meadows of Luzon, the Olympia's eight-inch guns in the forward turret burst forth at 5,000 yards range as the signal that the action should begin, she herself turning to starboard and leading the column past the enemy with port broadsides bearing. About the same time two white columns of water rushed upward in front of the flagship as if from exploded mines.

The smoke from the first discharge, as it sagged away, disclosed a long, lead-colored launch coming out from behind Sangley Point and standing rapidly toward the flagship, flying the Spanish flag. The secondary batteries of the flagship and Baltimore turned upon her a hail of shell, under which she stood on for awhile with plucky persistence, but finally fled toward Sangley Point, where she was beached and abandoned under the guns of the fort. She was afterward claimed by the owner of the marine railway at Canacao, a Britisher, who said she was only going to market at Manila, but as this man's Spanish sympathies and interests were strong, it seems quite probable that she had been impressed by the enemy as a torpedo-boat.

The battle had now commenced in earnest, and both squadrons were enshrouded in dense white billows of smoke, ever increasing in volume and incessantly pierced by red tongues of flame; while the heavy jarring reports of great guns, the hiss and scream of projectiles and the sharp bursting of shells added the awful majesty of terrific noise to the vivid grandeur of fire and smoke. It soon became evident that the Spanish Admiral was content to fight in his constricting position, which prevented his maneuvering the squadron as a whole, and left each of his ships to independent action in bringing their batteries to bear. In that stubborn combat of two and a half hours the Spanish ships fought like beasts at bay. Every divisional officer in the American squadron had studied the fighting qualities of each of the enemy's vessels, and every American ship, as if by common agreement, concentrated on the Reina Cristina, the enemy's flagship and most formidable vessel. Only when guns would not bear upon her were they turned upon others and then generally upon the Castilla, of equal size and armament, though built of wood. The shore batteries were permitted to keep up their incessant fire with only rapid-fire guns replying to them. The failure of these comparatively undisturbed batteries to score a single hit can only be accredited to execrable marksmanship, but the poor work of the Spanish ships was undoubtedly largely due to the murderously demoralizing fire which they were compelled to endure and to their bunched position.

The American squadron stood past the Spanish ships and batteries in perfect column at six knots speed, making a run of two and a half miles, then returned with starboard guns bearing. The first lap followed the five-fathom curve as marked on the charts, and each succeeding one was made a little nearer, as soundings showed deeper water than the chart indicated. The range was thus gradually reduced. Let the unprofessional reader note the great range of modern ordnance by pausing here to realize that with moving guns and moving targets a whole squadron was destroyed and hundreds of people killed a mile to three miles away.

Under the miraculous providence which ordered the events of that day those six American ships steamed serenely back and forth unharmed for nearly three hours. Shells flew over them, between masts and stacks and ventilators; shells fell beside them and flung sheets of water over their guns and gunners; shells falling far short bounded and wobbled over their mastheads; shells incessantly burst above, ahead, astern and around them, but on they went unhurt; their gunners unheeding the din, loading and training and firing with the rapidity, regularity and accuracy of machinery. Only three ships brought scars out of the fight—the Olympia, Boston and Baltimore. Fragments of a bursting shell ripped across the flagship's bridge, passing close to the Commodore and his chief-of-staff, and other fragments scarred her sides without penetrating. A well-aimed shot struck the Boston near the water on the port side aft. The shell burst in the drawers under an officer's bunk, wrecking and setting fire to the room, but prompt measures extinguished the fire. Another shell passed through this ship's foremast only a few feet from her captain as he stood on the bridge, but it fortunately failed to explode. Another small shell burst in her port hammock netting, starting a slight fire, which was quickly put out.

The Baltimore was less fortunate, being struck five times, not counting a hole in her flag at the main, a main brace (of a signal yard) shot away and a bare shave on the rim of the after ventilator. The first shell, a 6-pounder, entered under the starboard forward six-inch gun and burst harmlessly in a clothes-locker on the berth deck. The second, of the same caliber, struck at the waterline amidships on the port side and burst in a coal bunker. Another 6-pounder quickly followed some feet higher, cutting the exhaust pipe of the port ventilating blower engine on the berth deck, and exploding harmlessly, one piece sticking in the shoe-sole of the man running the blower engine. The fourth hit was perhaps the most remarkable in the annals of naval warfare, for a 12-cm. (nearly 5-inch) armor-piercing shell (weighing 55 pounds) crossed the ship's deck and returned, almost to the point of entry, passing each time through a group of fourteen men without actually hitting a soul. This shell entered the starboard bulwarks abreast the main rigging a few inches above the spar deck, ploughed up the wooden deck planking and struck a steel beam, cracking it through. The beam deflected the projectile upward so that it passed sideways through both sides of the steel combing of the engine-room hatch, after which it was again pointed straight, then struck the left recoil cylinder of the port 6-inch gun and glanced from this to the inside surface of the semicircular gun-shield. This changed its course nearly 180 degrees, and it flew again across the deck, struck an iron ladder on a ventilator, fell to the deck, spun rapidly on its side

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* One shell struck squarely on her starboard side and another cut the signal halyards from the flag lieutenant's hand. Her rigging and fixtures above her bulwarks were cut in several places.

and rolled into the waterway scarcely twenty feet from where it first entered. On its first trip this shell struck a box of 3-pdr. ammunition, bursting several charges. Fragments of these and splinters from the deck wounded two officers and seven men, all so slightly that many of them continued their duties after surgical attendance on the spot. The officer commanding the division, who received a slight wound in the arm, was standing upon the engine-room hatch (in order to see over the bulwarks) when the shell passed through it. He and several iron gratings over the hatch were thrown upward by the blow. A powder-man, near whom the shell passed upon its return trip, was rendered instantly unconscious from the windage, falling flat upon his face and not fully recovering consciousness for twenty-four hours. The port gun was disabled, for when fired again it would not run out to battery on account of the deformed cylinder. The last shell to score a hit on the Baltimore struck the water on near her port bow, ricochetted end-over-end above the heads of an 8-inch gun's crew and past the captain and navigator on her bridge; then tumbled into the cowl of a ventilator.

In the early part of the action the Baltimore's two quarter-boats were blown to pieces by the blasts of her own guns, and their remnants were cut adrift, making a gruesome wreckage in the squadron's path.

The pall of smoke which hung between the contending vessels prevented the effect of many shots from being seen, but close scrutiny with glasses gave the comforting assurance after the first twenty minutes that the enemy was being hit hard and repeatedly, and as the range grew less, so that gun's crews could watch the fall of their shots with the naked eye, many an exultant cheer went up from every ship. Naked to the waist and grimy with the soot of powder, their heads bound up in water-soaked towels, sweat running in rivulets over their glistening bodies, these men who had fasted for sixteen hours now swung shell after shell and charge after charge, each weighing a hundred to two hundred and fifty pounds, into their huge guns and trained these monster engines of destruction, weighing fifteen to twenty tons, all under a tropical sun which melted the pitch in the decks, utterly unconscious of fatigue, and oblivious of the fact that each and every one of them was in momentary danger of being mangled out of all semblance to humanity. Such is the exaltation of battle! Even greater was the endurance of those below, imprisoned beneath huge battle gratings and behind water-tight doors, facing the white heat of furnace fires and breathing an atmosphere at two hundred degrees; knowing not the tide of battle; knowing not if the shocks which continually shook their ships were from their own guns or from the enemy's shells, but knowing full well that for themselves in case of disaster there was no escape, but death amid the horrors of scalding steam, searing fire and in-rushing water.

Toward the end of the action the Cristina stood out as if unable to endure longer her constricted position, but the concentration of fire upon her was even greater than before, and she turned away like a steed bewildered in a storm. It was seen that she was on fire forward. Then a six-inch shell tore a jagged hole under her stern from which the smoke of another fire began to seep out. Right into this gaping wound another huge shell plunged, driving a fierce gust of flame and smoke out through ports and skylights. Then came a jet of white steam from around her after smokestack high into the air, and she swayed onward upon an irregular course toward Cavite until aground under its walls.

The Spanish Admiral's flag was now hoisted upon the Isla de Cuba, and many guns were turned upon it, but the excellent target presented by the white sides of the Castilla held for her a large attention. Shell after shell burst in her hull, and the dark columns of smoke which followed told of deadly fires started.

Then the Duero pointed her long ram out past Sangley Point, either preparing to use a torpedo or endeavoring to escape, but she received the same storm of shells as the Cristina, and retired on fire.

It was now 7.30. The Cristina was out of action and on fire, the Castilla's guns were almost silenced, and all the rest of the Spanish fleet except the Ulloa were retiring behind the mole at Cavite Arsenal, whence they could not possibly escape. It was at this time erroneously reported to Commodore Dewey that his ammunition was running short, so at 7.35 the flagship signalled "Withdraw from action," followed by "Let the people go to breakfast." Ten minutes later the American squadron stood out beyond the range of the persistent shore batteries and came to rest. Battle gratings were lifted and grimy men crowded on deck, clambering upon every available projection on the blistered, flame-scorched sides of their ships to cheer each other like demons released from Hades. Commanding officers were then called on board the flagship to discuss plans of final destruction.

Meantime let us look at the Spanish side. Having part of the Velasco's crew and additional marines from the Arsenal, the Reina Cristina is said to have gone into action with 493 men all told. As soon as the American gunners got her range the carnage was dreadful, but there were plenty to fill the dead men's places at the guns, and they were fought gallantly and without slacking for more than half the action. Admiral Montojo was posted upon the characteristics of all his opponent's ships except the Baltimore. She was a "Johnny-come-lately" in the squadron, of whom he had received but meager information. Her great apparent size, her heavy battery and her immunity from injury finally convinced him that she was a battleship. He then directed the Cristina's battery upon her with armor-piercing shells.

In the early part of the action a shell burst in the Cristina's forecastle, almost annihilating four rapid-fire guns' crews; a fragment striking the foremast and flinging splinters upon the bridge which disabled the helmsman. Lieut. Don Jose Nunez immediately took the wheel and steered the ship until her steering gear was destroyed. The next heavy shell burst among the crew's lockers on the orlop deck and started a fire which was with difficulty extinguished. Then an eight-inch shell pierced the shield on the port forward 16 cm. gun and burst in the midst of the gun's crew. This was just in front of the bridge. Under his very feet Admiral Montojo saw in a moment of time a gun disabled and twenty men torn to pieces.

The Spanish Admiral seems at last to have realized that to continue the fight where he was meant certain annihilation, and with desperation he headed the Cristina toward the American flagship. She could more easily have faced a hurricane. Shells of all calibers from every American ship plunged into her forecastle and swept her upperworks. An eight-inch shell, bursting forward, started anew the fire on the orlop which its companion shells now prevented from being extinguished, and it was necessary to turn the ship's bow from the enemy in order to fight the flames. As she swung broadside on a large shell plunged into her superheater and burst, scalding and killing a gunner's mate and twelve men. Next came a six-inch shell which burst in the ward room, already turned into a bloody hospital, tearing out the after part of the ship, killing the wounded and starting a new fire. Then the mizzen topmast and spanker gaff came down with a crash, bringing the Spanish ensign and Admiral Montojo's flag to the deck, but these were quickly rehoisted on other halyards.

A shell now carried away the steam steering gear on the bridge and an attempt was made to connect the hand-wheel aft, but the ship swung stern to the enemy and was exposed to a raking fire. The next large shell which hit killed nine men. Then came the *coup de grace*. An eight-inch shell plunged into the stern, annihilating the hand steering gear and the men working upon it, tore its way on a long slant to the engine-room and cut the exhaust pipe leading to the condenser.

The Cristina drifted aimlessly onward toward Cavite, followed by an undiminished hail of projectiles. Her blood-drenched decks were cumbered with redly dripping human fragments and writhing and groaning wounded. Only one gun captain and another petty officer, with a few unwounded sailors, now went from gun to gun in the waist of the ship loading and firing. Flames were licking their way from bow and stern, consuming the wounded as well as the dead. The after magazine was now flooded, orders were given to scuttle the ship, and the Cuba and Luzon were signalled to rescue the crew. The Duero also assisted, and boats from the arsenal, but scores of men were imprisoned beneath a roaring furnace with only the choice between rushing up to die in its devouring flames or remaining below to drown in the rising waters. The captain, Don Luis Cadarso, was killed by a shell while superintending the rescue of the survivors. All who could be gotten out of the doomed ship were landed at Cavite and mustered. One hundred and sixty answered to their names, and of these ninety were wounded. Thus, out of 493 on that ship, 333 brave sailors were dead or missing and 90 more were *hors de combat*.

Admiral Montojo estimates that the Cristina was hulled seventy times before he left her. An officer who remained on her to the last moment says she was hit far oftener.

The Castilla remained at anchor during the action, fighting her port guns until her port side was riddled, then by chance her chain was cut and she swung around till her starboard guns bore. Being a wooden vessel she was repeatedly set on fire and her gunners had frequently to leave their guns and subdue flames. About the middle of the action, after her wardroom had become filled with wounded, a large shell burst in it, killing nearly all and starting a fire which could not be subdued. The after magazine was then flooded. A little later another shell of large caliber struck her amidships near the water-line, bursting in the machinery and starting another fire which finally got beyond control. Toward the close of the action a third large shell burst under the forecastle and set fire to her forward. The forward magazine was cut off by flames so that it could not be flooded and the ship's destruction became a certainty. A prearranged distress signal was then hoisted and boats put off from Cavite to rescue her crew. Her captain and 23 men had been killed and 80 wounded. At about ten o'clock the last man who could be found alive was taken out, her flag was hauled down and she was abandoned, burning and sinking.

When the Cristina sagged out of action the next best target was the Austria and many more guns were turned upon her. Her bridge and pilot-house were completely wrecked by heavy shells. The steering gear was demolished and the man at the wheel killed. At this time, too, the gunboat Duero, after her dash, was running for cover with a fire under her forecastle. The Austria, having now to be steered below decks, was scarcely under control. Admiral Montojo realized he was completely beaten and made signal to retire behind the arsenal and scuttle and abandon the remaining ships. The demoralization is indescribable. Ships crowded helter skelter into Bakoor Bay, grounding and anchoring anywhere when out of sight of the enemy. The sea-valves of the Austria, Cuba and Luzon were broken, and officers and men hurried ashore without stopping for personal effects. Photographs of wives and daughters were afterward found upon their bureaus; silver toilet articles and *bric-a-brac* remained untouched; money lay scattered upon cabin floors. Admiral Montojo had a slight wound in his leg dressed in Cavite, then took a carriage and fled to Manila.

At this time the American sailors were at breakfast, the ships drifting idly upon the placid waters of the bay, shells from Manila and Sangley falling harmlessly some cable lengths away.

While the captains were with the Commodore a strange steamer was sighted coming up the bay and keeping close to the Cavite side. When the conference broke up the captain of the Baltimore was directed to intercept this vessel while the rest of the squadron stood in to complete their morning's work. The Baltimore was therefore considerably in advance of the squadron, standing directly in toward the beach across the steamer's bow, when the latter was discovered to be a merchantman, and the McCulloch was directed to stop her, while the Baltimore was signalled to lead into action. Sounding as she went, she got safely within 2,500 yards of the beach, then turned to port at 11.05 and steamed slowly, signalling "Permission to attack enemy's earthworks." Then followed for ten minutes a duel with the batteries which is attested by the onlooking squadron (not then within fighting distance) as one of the most magnificent spectacles of the day. The big cruiser, slowing and creeping along at a snail's pace, seemed to be in a vortex of incessant explosions both from her own guns and the enemy's shells. At times she was completely shrouded in smoke and seemed to be on fire, while every shell she fired was placed in the earthworks as accurately as if she were at target practice. Canacao battery was the first to fall under this deadly fire. Its embankments of sand, backed by boiler iron, were torn up and flung into the faces of the gunners until panic took hold of them. Hauling down their flag, they tumbled into an ambulance and drove madly to the protection of Fort Sangley. The whole fire of the squadron was then concentrated upon this fort. Its ramparts seemed to be in an incessant upheaval of earth from which dust and smoke and fire rolled away as from a volcanic crater. Three times its guns seemed silenced and the ships reserved their fire, only to see the plucky Spaniards begin again. At last, when, by Spanish accounts, a gun was disabled and six men killed and four wounded, the Spanish flag came down and a white flag was raised in its place.

There remained only the cruiser Ulloa, moored just inside Sangley Point. She had received some punishment in the first engagement, but her commander had not obeyed Admiral Montojo's signal to "scuttle and abandon." We cannot too highly admire the courage of this man, commanding a little cruiser unable to move and already severely crippled by the enemy's guns, who, with an order from his commander-in-chief to *sauve qui peut*, stuck to his ship for three hours within a stone's throw of the beach and safety, calmly awaiting the onslaught of the whole American squadron.

The Baltimore, drifting past Sangley Point, received the fire of the Ulloa and at once returned it with a raking fire. The Olympia, passing outside and abreast the Baltimore, also opened on her. The Raleigh, passing beyond both, turned Sangley Point and threw in a deadly cross-fire. The intrepid ship was literally riddled with shells, nearly every gun being dismounted or disabled. At length the crew swarmed over her unengaged side and swam for shore. Then she gave a slow roll toward her executioners and sank beneath the waves. Three masts remained in sight to mark her grave, from one of which still flew the Spanish flag.

Meanwhile the Boston advanced beyond the Raleigh toward the arsenal, past the blazing Castilla, but was stopped by shoal water. The Concord entered Bakoor Bay to destroy the transport Isla de Mindanao, which had been run aground. She opened fire with her six-inch guns and the transport was quickly in flames, her crew deserting her and taking to the woods. The little Petrel alone was able by her light draught to steam in to the arsenal, which she did with gallant dash. Those on the less fortunate ships held their breath, expecting to see her draw the fire of all the hidden Spanish gunboats, but after she had fired a few shots, which were not returned, the last Spanish flag was hauled down, and at twenty minutes after noon, a white flag was hoisted on the arsenal sheers and the Petrel signalled "The enemy has surrendered."

Sending his chief-of-staff to the Petrel to receive the surrender, Commodore Dewey steamed at once to Manila, followed later by the Baltimore, Raleigh, Concord, McCulloch and transports. The squadron anchored off the city as unmolested as if in time of peace. The sun went down amid the usual evening concert and one could scarcely realize that he had just participated in the most complete naval victory of modern times.

Yet over at Cavite lay ten warships burning, exploding and sinking; a squadron annihilated; a navy yard captured and nearly four hundred Spanish dead and wounded. On the American side not a ship disabled; not a man killed.*

It is impossible in closing to refrain from summing up the results already apparent of this remarkable victory:

It gave a prestige to the American arms at the very outbreak of hostilities which commanded the respect and admiration of nations which might otherwise have been hostile.

It swept all Spanish naval force from Pacific waters, relieving even the most timorous from all fear of a raid upon our Pacific coast or Pacific commerce.

It gave the United States a vast and prolific territory to hold for ransom or retain as indemnity.

It necessitated and brought about the capture of Guam and the annexation of Hawaii.

It diverted the Cadiz fleet from Cuba, thus permitting the whole Atlantic cruising force to concentrate on Santiago and Cervera.

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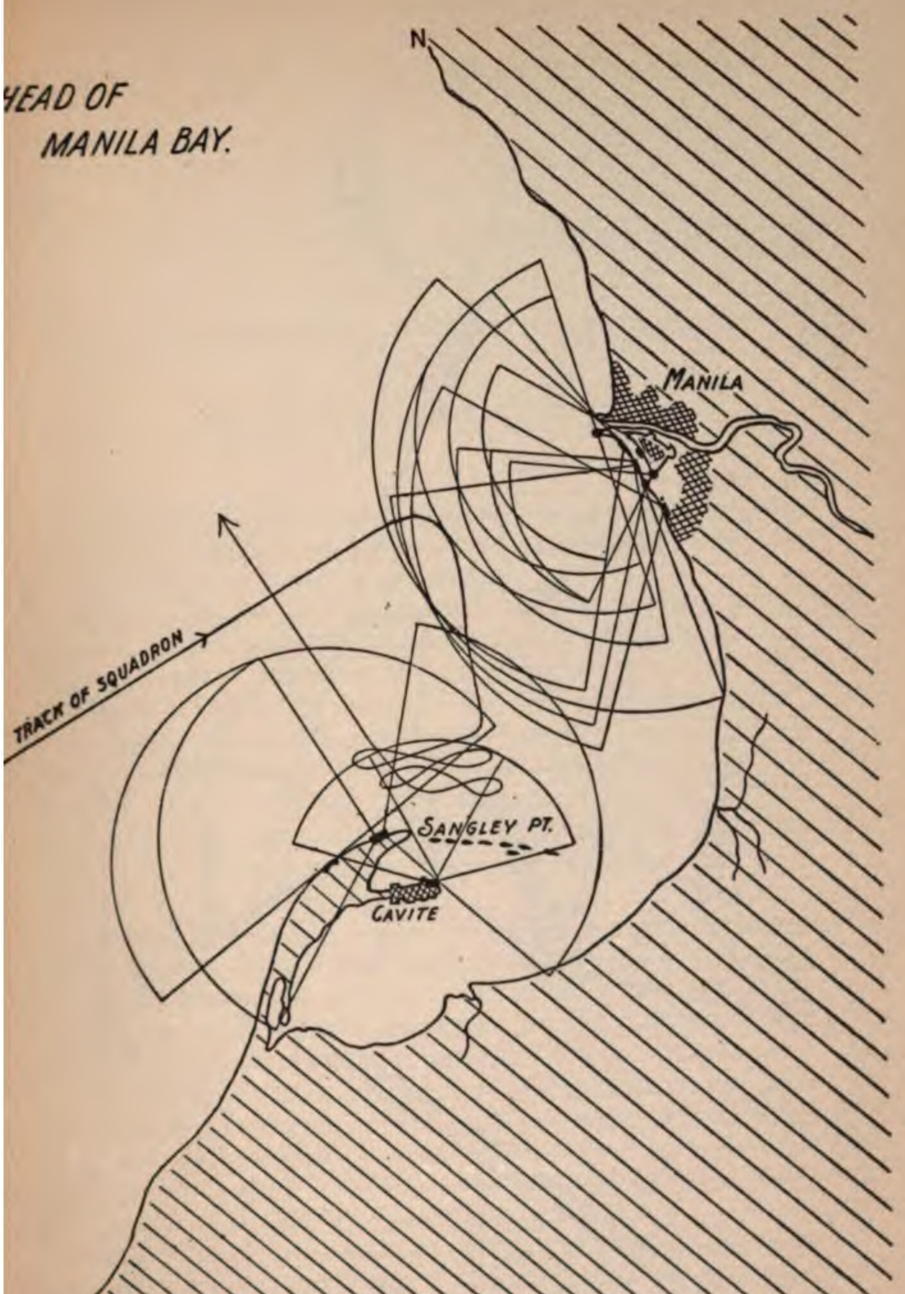
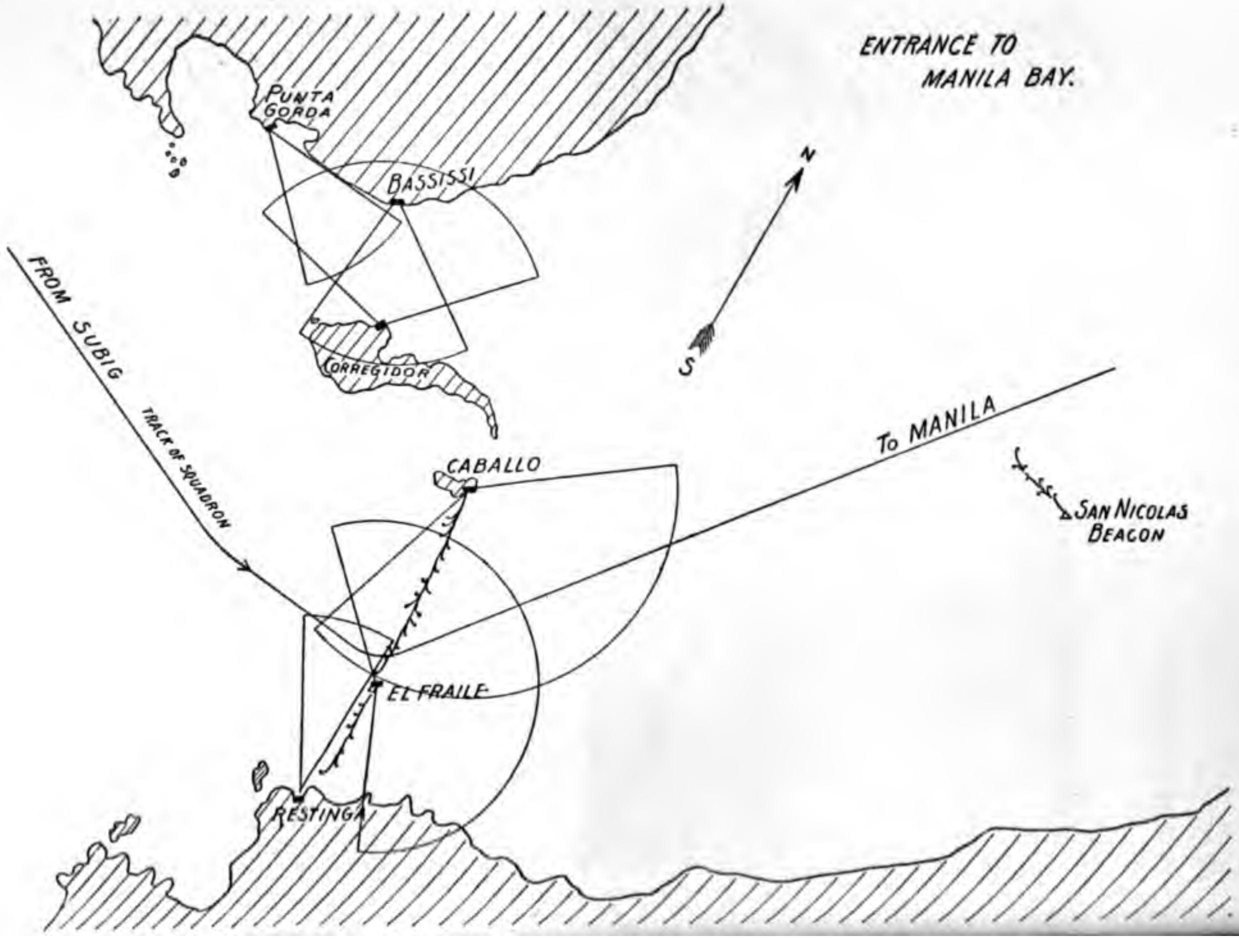
* The writer has endeavored to reconcile many statements of Spanish casualties. Governor General Augustin's official dispatch to Madrid, as published in the *New York Herald*, states that the total loss was 618. Admiral Montojo's official report, as published in *El Imparcial*, Madrid, states that 381 were killed and wounded. Statements of surgeons and other officers who were on the ships and in the hospitals add up to very nearly the higher figure, as killed or missing alone.

HEAD OF MANILA BAY.





ENTRANCE TO MANILA BAY.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

WITH REFERENCE TO THE SIZE OF FIGHTING SHIPS.

CAPTAIN ASA WALKER, U. S. N.

The question has been propounded as to whether the maximum size of battleships has not been reached or, indeed, exceeded in the construction of vessels of 15,000 tons.

The most vital objective points to be considered in the building of a battleship are, I believe, power of offense, power of defense or self-protection, facility for maneuvering or handling, capacity for carrying the sinews of war, and *speed*—these added to the paramount requirement of proper stability. According as these qualifications are in demand, so should the vessel be designed. While it would seem impracticable to combine all good points in a single ship, arrangement may possibly be made for a degree of excellency in each that may produce a vessel of a desirable type of all-round efficiency.

By loading down a hull with armor and guns, a vessel of moderate draft and tonnage may readily be constructed possessing powers of offense and defense to an extreme limit, but coal capacity and speed must be sacrificed, so that each vessel becomes little more than a floating battery, and, to a certain extent, may be classed as a fixed defense, tied, as it would be, to the immediate shores and ports of its owners. Under this head may be classed all coast-defense vessels of whatever type; vessels which, though placed in the line of battle, could not keep position and would be unable to push home a victory.

Seeking, therefore, to preserve as far as possible those qualities that render a vessel formidable, to add the other qualities that make it useful beyond its immediate station, there is but one path, and that lies in the increase in displacement.

To accomplish this end, it will suffice to increase any one or all of its dimensions; but since it may be assumed that the limit of draft for us has been reached in vessels of 11,000 tons, further variation is limited to increase in length or breadth, or both.

Now, if we assume a fixed length as well as a fixed draft for a vessel, it will readily be seen that the displacement will vary directly as the width given, while the surface will increase in a much smaller ratio, until the limit of breadth-equal-length is reached; *e. g.*, the Alabama class, with dimensions, length 368 feet, breadth 72¼ feet, and draft 25 feet 6 inches, has a displacement of 11,525 tons. If, now, we construct a similar vessel with the same length and draft but with a breadth of 75 feet, we shall have a displacement of 11,963 tons, an increase of nearly 4 per cent in displacement, at the expense of less than 1 per cent of excess over the former hull in structural weight. Again, retaining the same draft and constructing a hull of 400 feet in length and 75 feet in breadth, a gain of 1,678 tons will be made over the original structure in floating capacity or 14.6 per cent of original displacement, at the expense of 7.2 per cent addition to structural material.

These comparisons are made under the supposition that the engines, boilers, armament, etc., are unchanged; what effect such changes would have on the speed I am unable to say, but it could be but slight at most. It will thus be seen that, at a moderate expense and with little if any sacrifice of efficiency, the coal and store capacity can be increased very materially.

If there existed in the Constitution a clause prohibiting the employment of a United States battleship outside of her own continental territorial waters, there would be no *raison d'etre* for the battleship with large possible radius of action, and the bunker and store-room space could well be made small and the size of the vessel kept well below a 10,000-ton margin. With coaling facilities always under the lee, and storehouses at command, the necessity for large quantities of supplies on board is obviated. It is, however, impossible to predict the scene of our future conflicts on the sea, and surely it will not be left to our option where we are to engage; we must, therefore, make provision for operations both at home and abroad. If, by increasing the size of our battleships to even 15,000 tons, we can combine to an eminent degree all the requisites that go to make the most efficient fighting machine, would not the truest wisdom be displayed by so doing? What would it profit, if by reducing displacement and, to a small extent, cost, we produced a battleship lacking to a vital degree one of the necessary elements?

My knowledge of the theory and practice of naval architecture is so slight that I am unable to venture an opinion as to whether it may not be possible, considering the recent improvements in armor, to construct vessels of moderate displacement that shall present, in a high degree, all the desirable features. It would seem a most wise and judicious course to pursue, while reducing the thickness of the armor plating as now placed, to give better protection to that portion of the battery outside the turrets; in fact, to make a redistribution of the armor. Should this be done, there can be little hope that the total armor plating can be materially reduced, and we must hark back to increase in size for endurance in cruising.

A comparison of one of the latest French battleships, the Henri IV., with the Russian Sissoi Veliky, of practically the same tonnage, will illustrate the position:

	l.	b.	dr.	Normal coal.	Radius at 10 k.	Armament.	Disp.
Henry IV.......	350	73	23	725 1100	7500	2–10.8″, 5–5″	9000
S. Veliky.......	341	66½	24	500 800	3000	4–12″, 6–6″	8880

In the former it will be seen that the armament has been sacrificed to coal capacity, and in the latter the reverse is noted. There can be no two opinions as to which of these would be the more valuable unit in battle, nor can it be doubted which would operate the more successfully at 3,500 miles from its base.

What I mean to say is, if the Alabama be selected as the highest type of the battleship, with the standard battery and protection, and the draft be limited to her normal draft, that a battleship displacing 13,200 tons, with the same battery and protection, would be quite as efficient offensively and could extend her operations to twice as distant a field.

The argument that by increasing the displacements we are tending to the diminution of the number of units does not seem well taken. We sometimes see in reports lists of ships proposed, with the individual and aggregate tonnage, yet I have failed to discover where this latter item has appeared in the bill authorizing the construction. The practice has always been to specify the number of each class legislated for, with the approximate tonnage of each. The aggregate tonnage of the various navies of the world is given as a rough means of comparison, but it conveys no more accurate idea of the real strength, than would the announcement of the aggregate number of units, irrespective of class.

What relation the number of vessels in the various classes should bear to each other has not as yet been determined. It is evident that the vessel *should* be designed, primarily, for the duty it is to perform. This is possible only to a limited extent and in exceptional cases. The fast cruiser, for scout duty, can be given great speed; but she *may* be forced to fight, and hence must possess some means of defense and offense. In all the classes, from the battleship down, some desirable points must be sacrificed to the attainment of a general good average.

It seems to me that the question to be determined is how to make the most desirable fighting unit. If a specified battery be assumed, with the maximum amount of protection to it and the personnel, there remains but the decision as to how and where this battery may be put in action. The hull is but the vehicle on which it moves, and upon its size depends entirely whether the work is a floating battery, a coast-defense ship, a restricted battleship, or a battleship with great sea endurance; the latter will include all the good qualities of all the other types, and differ only in size or displacement and capacity for long-range work. If a given displacement be necessary for battery, engines and boilers, ammunition, stores, internal fitments, armor and hull, then there should be no hesitation in increasing the size of the vessel until adequate provision is made for fuel, to ensure a long range of operation—economy in this direction is "penny wise and pound foolish."

The verdict of maritime nations possessing efficient sea power seems to be that the high-power 12-inch gun constitutes the most powerful arm advisable to put afloat. This gun has, therefore, been adopted as the *piece de resistance* of the latest constructions. The caliber of the "intermediate" battery varies from 4.7-inch to 6-inch R. F. of high power. The main batteries of the last authorized battleships for the United States are as follows:

	M. V.	M. Energy.	Wt. Shot.
Four 12 in. 40 caliber......	2800	46,186 ft.	850 lbs.
Sixteen 6 in. 50 caliber.....	2900	5,838 ft.	100 lbs.

Taking this as a sample unit of battery, the hull should be built sufficiently large to carry it into action wherever desired.

The modern armored cruiser, in the matter of protection, may be looked upon as a modified battleship. There seems little doubt that she will have her place in the line of battle. In battery, she lacks the heaviest guns furnished to the battleship, but has an intermediate and a secondary battery of a high order of efficiency. Her rôle in a nation's fleet is assumed to be that of a vessel possessing in a high degree offensive and defensive qualities, with the capacity of delivering her attack at points far distant from her base and in the least space of time. A proper distribution of armor renders her practically invulnerable to the attack of any vessel other than the battleship or one of her own class. Her quality of high *speed* permits her to accept or refuse battle from any but her own class. To possess the qualifications demanded for the services required, it would seem impossible to restrict her to even moderate limits in displacement. With unit of battery and protection determined, the same argument as in the case of the battleship would apply for size, to give the requisite range of action and extreme speed. If our navy has any need at all for the armored cruiser, it seems to me that it demands one of a class that possesses, in an extreme degree, the qualifications of speed and sea endurance. To sacrifice either of these essentials would be to blot out all reason for her existence. Here, also, is a problem for the naval constructor, and to him must be referred the question as to the displacement necessary to meet the requirements.

Two methods are proposed to obviate the necessity of sea endurance in armored vessels; these are, the establishment of convenient coaling stations, and accompanying colliers. Good common sense recognizes the value of well selected stations and facilities for coaling in times of peace, at points remote from coal markets. Coal piles at distant places, however, unless rendered invulnerable to attack from an enemy, in case of war would belong to the nation whose forces were first there, and could not be depended on to supply the needed fuel to ships of the country by which they had been established.

Let us consider our three coaling stations established in the Pacific—at Honolulu, Guam, and Tutuila. None of them has any fixed defenses, nor are such defenses even proposed. All are wide open to attack from any class of vessels, even the least protected. To insure immunity from a raid, it would be found necessary to keep armored ships in each harbor, thus withdrawing such force from its legitimate duty.

Guam especially occupies a most dangerous position. At less than one-third the distance from the ports of China and Japan to what it is from a home port, how long could one reasonably hope that it would be left undisturbed in our possession or be free of access to our cruisers seeking to replenish empty bunkers? It is safe to predict that, in a war with any nation having a fleet in Asiatic waters, our enemy would very soon be in possession of a new coal base at Guam. The same would be the result as to Tutuila, and probably Honolulu. Leaving the last, however, out of consideration, assuming that it is too far from the enemy's base to warrant immediate action, what would be the condition of a single battleship or fleet, whose coal supply admitted of a sea endurance of only 3,500 miles, which should attempt a passage to the Philippines from Honolulu, trusting to fill the empty bunkers at Guam, and finding, on arrival, that the place was either held in strong force by the enemy or had been captured and all its supplies destroyed? With only a single day's coal in the bunkers and 1,400 miles from Manila, the nearest port of supply, would not the condition be, in the utmost degree, desperate? The sole remedy to prevent such a possible condition is to make each isolated coaling station self-protective. In other words, whenever such a station is to be established, with the intention of relying on it to perform its functions in time of war, it must be strongly fortified and occupied by a sufficient garrison to keep its defenses up to a proper standard, and in case of need to hold those defenses until relieved. As items of strength in time of war, undefended coaling stations will be found to be staves, compared to which the proverbial "broken reed" would be strong and helpful. As a matter of dollars and cents, the fortifications and garrisons may be found so expensive as to compel recourse to other means to provide the desired coal, and here will appear the collier.

Heretofore, vessels known under the name of *colliers*, and employed either to carry coal to the ports of the world or to accompany fleets as vessels for fuel supplies, have been constructed with two main objects in view—great capacity and economical service. In arriving at these desired results speed has been sacrificed, all the lines—if lines they can be said to have—have been fulled until we find immense, almost rectangular prisms *crawling* across the seas, but doing wonders as to miles per ton of coal. That a war fleet accompanied by colliers may move with proper speed, vessels of a class different from the one above described must be employed. The lines must be finer, the speed greater, and probably the freight capacity reduced. This latter must indeed be the case, if unwieldly size is to be avoided, as a much greater ratio of its capacity must be devoted to its own fuel, if increased sustained speed be a requisite. It was satisfactorily proven in the late war that vessels of this character are not in the market; it would therefore seem necessary to build a fleet of what we may call " war colliers," the number keeping pace with the number of war vessels in the fleet. Shall we assume that each of these colliers has a coal *freight* capacity of 4,000 tons, and that for each two battleships and armored cruisers in a fleet on foreign service, one collier is detailed. Thus, to each fleet of armored vessels would be attached half its number of defenseless non-combatants, whose protection becomes the very life of the fleet itself. I believe that it is a well-known and accepted principle of sea warfare that a fleet, upon which depends the security of vessels unable to help themselves, is handicapped from the start. In all services, convoy duty has been considered the most onerous and one in which all the advantages are with the attacking enemy. It is possible, moreover, to conceive of the entire destruction of a convoy, while the convoying fleet remains intact and exists still as a fighting unit. In the fleet we have under consideration there exist the disadvantages of convoy, together with the paramount necessity that *this convoy* must be kept intact. It has forced on it three duties—offense, defense and protection—the last adding seriously to its troubles. It would seem, therefore, as a justifiable conclusion, that a fleet with its surplus of coal stored in accompanying colliers ought not to engage in general action, unless it is in such superior force as to insure the safety of its supply vessels. A single battleship, with its attendant collier, would be in worse case than a fleet, as it would, at all times, be risking the loss of its convoy from the sudden dash of a swift cruiser.

Even with an accompanying fleet of colliers, the range of action is limited by the coal carried, and the necessity for protected bases still exists, though such bases may be more widely separated.

Unquestionably, the ideal battleship would be one with its powerful battery adequately protected in a hull of moderate displacement, with a limited supply of coal and capable of a moderate, not excessive speed. This, with defended coal depots in all directions, spaced well within limit of her sea endurance, would insure the best results with least outlay on each unit of the fleet. But such an arrangement of coaling stations is geographically impossible and their protection impracticable, and it will be found necessary to limit them in number and location.

Would it be a wise policy, for the sake of keeping down the displacement, to confine the scope of our battle fleet to a very restricted radius about a coal pile, when, by increasing the displacement by 2,000 or 3,000 tons, the radius of action could be so increased as to permit operations to be carried on at far more distant points, and with the coal supply safe within the protecting walls of the ship herself. That this condition may be possible, the attempt to secure high speed for the battleship must be abandoned, and the *maximum* of speed be fixed on conservative lines. To strive for a higher speed than seventeen knots will involve the sacrifice of endurance, to a degree not compensated for by the increase in mobility.

My conclusions are as before stated: For a battleship, a standard unit of battery and protection should be fixed by the Department, and to carry this battery into action a hull should be designed with sufficient displacement to accommodate machinery and boilers for a *moderate* speed, with capacity for a coal supply to allow of not less than 7,000 miles of sea steaming.

The armored cruiser should have a greater radius of action and should also be capable of very high speed for emergencies. Coal stations *must* be established, but those to be relied upon in time of war *must* be fortified and made secure.

PROFESSIONAL NOTES.

COALING WARSHIPS AT SEA.

Out of several plans which have been tried for transferring supplies from one vessel to another on the open sea, the American naval authorities have found one which seems to be practicable, as the tests made of it have proved quite successful. This is the idea based largely upon the plans of Naval Constructor J. J. Woodward, elaborated by the Lidgerwood Cableway Company, and depends upon an aërial cableway for its operation. It is intended to be utilized by ships stationed at a distance of from 350 feet to 500 feet apart. Possibly it might work successfully at a greater distance, but such an experiment has not as yet been tried. The vessels are connected by an ordinary cable, and the towing vessel gets under way at a speed ranging from 4 to 8 knots an hour according to the condition of the weather and the sea which is running. A speed of 5 knots in moderately rough water has been found sufficient to keep the cableway taut and to maintain the proper distance between the craft, unless a tide or some unusual current is encountered. With the connection made between the ships, the work of erecting the cableway is begun. This occupies from one to two hours, the supports being a movable framework or shear poles on the deck of the vessel coaled and one of the masts of the collier.

The apparatus which has thus far been used may be described as follows:

An engine, with double cylinders and double friction drums of special design, is located just abaft the foremast of the collier. It has two steam cylinders, 12 inches by 12 inches. A ¾-inch diameter steel rope is led from one drum over a pulley at the masthead, and thence to a pulley at the head of shear poles on the warship, and returned to the other drum.

The engine moves in the same direction all the time, and tends to wind in both parts of the conveying rope. One drum hauls in its part of the rope, and the other pays it out under tension by the slipping of the drum. A novel form of load carriage is supported by this rope. It is provided with a grip on the upper part and wheels to run on the lower part. This carriage carries two loaded bags, weighing 420 lbs. each, suspended from a bale which hangs in a hook below the carriage. An elevator takes the bags from the deck, hoisting them to the masthead. The conveyor carriage, in coming in to the masthead, locks itself under the bale. As soon as the bale is released—by a man stationed on the trestletrees—the engine operator hauls in the lower parts of the conveyor line. The upper part of the conveyor line is thereby drawn from the rear drum, slipping the specially contrived friction devices. Thus the carriage crosses from collier to ship, the tension being sufficient to ensure the bags clearing the water between the vessels. The rope is drawn in at a speed of 1000 feet per minute, and, if the points of support—masthead and shearhead—do not vary, the upper part will be drawn out, under tension of about 3000 lbs., at the same rate of speed. If, however, the distance is increased during the transit of the load, the extra rope called for is given by the slipping of the upper part from the drum. This increases the speed of the upper part. On the other hand, if the ships reduce the distance between points of support, the speed of the upper part is reduced.

When the carriage reaches the pulley at the shearhead it collides with it—at reduced speed—and thus striking, releases the lower hook, and the two bags and their bale drop into the canvas shoot and slide to the deck of the warship. Loads drop in this manner at the rate of one per minute. The empty carriage is drawn back by the rear drum, the forward drum being thrown partially out of friction.

An auxiliary rope, known as the "sea-anchor line," is stretched above the two parts of the conveyor line and under a pulley on the carriage. This rope is attached by a "knock-off hook" to the superstructure of the warship, and rests in a "saddle" on the shearhead; thence it leads through the carriage, over pulleys at the head of the foremast and mainmast of the collier, and on astern several hundred feet into the sea. On the end of this rope a drag or "sea anchor" is attached, made of canvas in the form of a cone. This sea anchor is selected in reference to the speed with which the ships are to travel. In a smooth-water test, speeding at 6 knots, a drag 7 feet in diameter at the base is used. During the rough-weather trial, the same anchor seemed to give the required tension at 5 knots.

The sea-anchor line is to support the carriage, when empty, on its return to the collier. It permits the conveyor line to be slack, and prevents the overturning or twisting of the carriage. Doubtless at times it helps also to support the load in transit across, but photographic views, taken during the passage of the load show the sea-anchor line slack, thus demonstrating that the tension device on the conveyor line is sufficient to sustain the load at a sufficient elevation during its transit.

The tests, which were made by a board of United States naval officers, showed that from 20 to 25 tons of coal per hour could be delivered from the collier to the vessel even when the wind was blowing a moderate gale. The towing vessel—which, in this instance, was one of the American battleships—consumed from three to four tons of coal an hour. Consequently, the amount actually received into the bunkers ranged from 16 to 20 tons, which would be an average of 375 tons in twenty-four hours. It is claimed that such a low speed would not be necessary in regular service, and that the vessels might proceed at a speed of from 8 to 10 knots an hour if desired. However, the consumption of coal on the towing vessel would be largely increased unless the collier could proceed under her own steam. There is danger, however, that the proper distance to be maintained might then be lessened, and the cable would sag, which would cause a cessation of the operations.

While one of the principal advantages claimed for the system is that a battleship or merchant liner can take on coal on a voyage without the necessity of entering the harbor, thus saving time, the process of transferring fuel can be carried out with a very small force of hands. One man is required at the hoisting engine, which is very similar to the steam winch now used for transferring cargo on board the modern merchant steamships. A squad of twenty men is required in the hold of the collier to fill the bags and deliver them to the deck, while another squad of from sixteen to twenty is used as passers to transfer the bags to the elevator. But one man is required ordinarily to do the overhead work, and is employed in the trestletrees of the collier, although two are employed when the weather is rough and the ship is pitching heavily for the purpose of safety. The only hands required on the receiving ship are at the top of the platform or shearhead, to empty the bags into the canvas shoot and return them. There is a force of bunker trimmers in the hold.

In the coaling of the battleship it was found that the loads could be transferred at the rate of one a minute without difficulty, owing to the speed maintained on the cableway. During the trial in a higher sea fear was expressed that the cables would become too taut by the rising of the vessels, that the supporting gear on the battleship between the mast and the collier might be sprung or carried away, but such was the plan of fastening that no damage of this kind was done. Although one vessel pitched so heavily that her bows went under water with every wave, the operation of coaling was conducted without difficulty, although the rate of loading was somewhat slower, the average being three or four tons per hour less.

Special trials have been recently made by the American Navy Department of coaling vessels in dock from lighters or barges. The battleship Iowa has taken on board 1000 tons in 11 hours and 25 minutes, while as high as 125 tons an hour have been placed in her bunkers. It must be understood, however, that this was accomplished by receiving the coal at seven different points, the crew being divided into as many divisions. The general plan pursued was to transfer it in baskets or bags through lines of men from the hold of the barge to the hatchways of the warship. Of course, the conditions are so radically different that no comparison can be made between this plan and that of loading at sea, which, of course, would be considered an emergency.

The experiments which have been conducted by the government with the system referred to have aroused such interest that a number of American ship-owners are considering the idea of utilizing the apparatus for supplying coal to liners at points where the harbors are too shallow to admit the placing of fuel on board their ships when loaded by the usual methods. It is understood that further trials are to be made by the government with the view of furnishing meat and other provisions as well as necessary supplies while at sea.—*The Engineer*, July 27, 1900.

MODERN NAVAL TACTICS.

Ernst Siegfried Mittler and Sohn, Berlin, publish in German a work on naval tactics by an officer of the Austrian navy, Capt. Rudolf von Labres, "Die Flottenfuhrung in Kriege auf Grund des Doppelstaffel Systems."

In his chapter on the Spanish-American war, the author says: What a high price Spain had to pay for the neglect of her navy is shown by the events of the war; and what a high price America might have had to pay if Spain had been at all adequately equipped may be seen from subsequent events. Spain, in anticipation of eventual complications with the United States, should have reinforced the flotillas stationed in the Philippines and the West Indies with modern cruisers and torpedo-boats. Even considering the Spanish battle fleet as a whole and assuming that it had been in complete readiness at the time of the contest with the United States fleet, the superiority of the latter was nevertheless so great that nothing short of very inefficient leadership on the part of the United States navy would have enabled Spain to carry off the victory.

Whether the Spanish chose Manila Bay as the scene of battle, or whether they had sought protection in some other harbor, the same fate would have overtaken them.

As it was, the battle took the shape of a duel between obsolete guns on the one side and the most modern guns on the other in which the medium-caliber R. F. guns carried off the victory. The losses of the Americans are hardly worth mentioning, and show how little risk they were running in this action, which, nevertheless, caused Spain to lose the Philippines.

A technical estimate of this battle is hardly possible, because tactical objects were not pursued, nor could they be pursued, on either side.

If we consider now the events of the West Indian scene of action, we find here also on the part of Spain, especially on the part of the highest authorities, uncertain groping about and a lack of a correct estimate of situations.

The arrival of Cervera's squadron in the West Indies, with scant coal supplies and weakened by the departure of the destroyer Terror, which had to be sent to Martinique on account of serious injury to her engines, did not mean a strengthening of the Spanish power in any sense, especially in view of the prospects of a battle with the entire hostile fleet.

A still greater mistake lay in the fact of this squadron—by order of the naval authorities, as was subsequently learned—running into Santiago harbor, which lay out of the way of the Cuban scene of action proper. The Spanish squadron would have been as strong as either of the hostile squadrons (Sampson's or Schley's), and it may be assumed that it could have gained Havana, which was within easy reach, especially if the last portion of the run had been made at night.

The first great strategic move on the part of the Spanish naval administration was therefore the despatching of Cervera's squadron to the West Indies without awaiting the equipment of Camara's squadron; the second, and even greater, mistake, the ordering of the squadron into the rat-trap at Santiago.

The military achievements of the Spanish squadron in Santiago harbor are deserving of high praise. The organization and armament of the forts, the closing of the harbor with mines, and the repulses of the different attacks of the powerful United States fleet will ever remain a credit to Cervera. It affords us satisfaction to say that the army and navy vied with each other and that they acquired a military reputation for their valor in the battles around Santiago.

How much might have been accomplished with some spirit of enterprise by the flotilla composed of two destroyers and three torpedo-boats! It is hardly conceivable that some attack made on a dark night during this period of heavy tropical rains would not have been crowned with success. What serious injury the hostile fleet might have suffered from a single successful attack by torpedoes!

Another opportunity, also, of injuring the enemy, the landing of the transport fleet, was allowed to pass by without any attempt to ward it off. Although the Spanish fleet had available for such purposes two torpedo-boat destroyers of 30 knots speed, whose sortie at night would have been practicable, no one seems to have thought of embarking upon an undertaking which promised so much success. How could these convoys have defeated a torpedo-boat attack at night made by vessels of three times superior speed? Such an attack, taking for granted it was carried out with skill, courage and a little good luck, would have led to the destruction of several of the transports and perhaps to the abandoning of the whole undertaking.

We must deny the expediency of the sortie from Santiago at that time. After the United States troops had been successfully landed under the protection of the fleet and were carrying their offensive to the very gates of Santiago, it was not advisable for the Spanish fleet to leave the harbor, thereby permitting the hostile fleet to enter, which must eventually have led to the bombardment of the invested city from the sea, and the loss of Santiago.

As to the sortie itself, the manner in which it was effected cannot be called anything but blundering.

Such an attempt, therefore, could have been undertaken with any prospect of success only at night and would have been practicable even though the harbor entrance was electrically illuminated by the Americans.

The naval battle of Santiago was inadequately prepared, poorly carried out and—and this is the greatest mistake—entirely unnecessary at that time. The leadership on the sea in all the encounters of this war was inadequate, and the Spaniards have proved again what they had shown at Trafalgar and in previous battles, that they knew how to fight and to die on the sea but not how to win.

The cause of all the failures of the Spanish lay above all in the improper strategic distribution of the naval fighting forces. The events of this war might have taken a very different turn if the Spanish fleet, composed of Cervera's and Camara's squadrons, both well equipped, had operated jointly in the West Indies.

The achievements of the United States navy in this war deserve no doubt high praise. As no tactically conducted battle occurred, we are not in a position to express an opinion on the nature of the tactical leadership of this navy.

The rapidity with which the navy was equipped and reinforced, all measures subsequently taken for the blockade of Cuba, the energetic command of the different ships in various minor actions, and, finally, in the battle of Santiago, are worthy of the highest recognition.

Entirely without result were the different bombardments of coast defenses, as for instance at Porto Rico and the repeated attacks upon the temporary works at Santiago. This is another proof of the fact that in contests of fleets with coast defenses, the latter are at a great advantage.

An enterprise carried out with unquestionable valor and great technical skill was the sinking of the Merrimac in the entrance of Santiago harbor.

A very noteworthy performance was the fast trip of the battleship Oregon from California through Magellan Strait to the West Indies, without any detriment to her power of action.

As to the technical conduct of battle fleets in close action, the last war has not contributed any more lessons than the other two wars previously discussed. Once more, as in the battle of Yalu, we note the preponderant influence of guns in all phases of battle, which justifies the opinion that the exclusive effectiveness of this weapon may result in the future in a modification of battle tactics. Therefore the great influence of this weapon, which must at once become apparent in battle, may, as stated in the tactical part of this work, lead to the conduct of battles at very short range, that is to say, to close action, and hence also to the utilization of the remaining weapon, the torpedo and the ram.

But the definite solution of this question must be left to the future. We must await the first clash between two navies ot equal strength to show the relation between theory and practice. But until then, in the absence of any theoretic treatment of this subject, we will adhere to the tactical principles and rules hereinbefore laid down.

For a translation of these extracts we are indebted to the Naval Bureau of Intelligence.—*Army and Navy Journal.*

MODERN TRAINING IN SEAMANSHIP.

J. R. Thursfield, in a paper read before the United Service Institution, holds that the advent of the torpedo-boat and destroyer for the training of navy officers, just as sails were becoming extinct, is almost providential. This is in line with the opinion we have heretofore expressed as to the value of these small craft as a means of giving young officers the training for independent command which they cannot get on a huge battleship. The inevitable tendency of such constructions is to destroy the individuality to which the greatest successes in naval war are due. Mr. Thursfield's subject was the training of seamen and he drew his conclusions from the accepted principles that a seaman is one who has assimilated the sea as an organic part of his experience, and is as familiar with it as any other craftsman with the materials of his craft, and that a gun's crew or a ship's company, or any organized aggregate between the two, is an organism articulate, coherent and instinct with the sense of common action and comradeship. These two elements of a fighting seaman's efficiency were his subject, and he described the sea as the condition common to both. The advent of sails transferred the center of naval gravity from the Mediterranean to the Atlantic, and Mr. Thursfield insisted that the advent of steam is not unlikely to transfer it to the far larger and more distant areas of the Pacific Ocean. In considering the question of a substitute for the vanishing discipline of masts and sails an analogy was drawn between the discipline of the sailing ship and that which is given by Greek and Latin—" the Humanities "—in a liberal education. The purpose in retaining these is to brace the mind, quicken the intelligence, enlarge the sympathies, and stimulate generally the faculties of the mind; and when Greek and Latin were dead languages the teachers retained them for their purposes, with beneficial results which none can gainsay. In the opinion of Mr. Thursfield, the essential qualities of self-reliance, resource, quickness of eye and steadiness of nerve, self-possession and steadfastness in danger and helpfulness in difficulties, cannot be gained without this discipline of masts and sails. A very distinguished officer, who was no advocate of retaining masts and sails, said to him, " I felt myself to be 50 per cent more worth as a naval officer after two years' experience of that training." In a very lively discussion which followed the reading of the paper, Sir Culme-Seymour said that in his own experience the seaman of to-day was better than his predecessors, whereas if the arguments of the school of masts and sails were valid, he should be worse. The crew of the Ramillies, the smallest men physically he had ever commanded, were, in discipline and seagoing qualities, as good as any he had met; and he asked his hearers to carry back their minds to the Crimea, and say whether the naval brigade at Ladysmith was not in every way as good as the brigade in the old days. He looked upon the discussion as the last dying gasp of masts and sails. Taking the same line, Sir N. Bowden-Smith contended that the men must be trained in the ships in which they are to fight, while Sir John Hopkins expressed the opinion that as good men could be got without masts and sails as with them. All of these officers agreed, however, that more training at sea was required. A large number of officers of junior grades, commanders and lieutenants, took part in the discussion, and all of them advocated the old system of training. All of the speakers agreed that this gave just the qualities required in seamen, and that the present system for training British seamen is a failure. The doubt was as to whether the resuscitation of a training-ship squadron of four-masted vessels would remedy the evil.—*American Shipbuilder*, Aug. 9.

A BRAZILIAN ESTIMATE OF ENGLISH NAVAL EDUCATION.

In the April number of the *Revista Maritima Brazileira*, Vice-Admiral A. de Jacequay, of the Brazilian navy, appears in the very unusual rôle of a foreign apologist for the educational system followed in the British navy. In this matter of naval education, England carried out one system; all the navies of Europe, of America, of the world, have another. China, indeed, established some years ago a feeble, half-hearted imitation of our own method, but when the navy of China was demolished by Japan, her system of naval training necessarily perished also.

The distinguishing feature of the English system is to get the cadets to sea at as early an age as possible, and to keep them there. In other navies the aim is in general to complete the preparatory training in training-ships, or colleges, by means of a course covering three years, five years, or even a longer period still, and to turn out the young officers at the end ready to discharge responsible duties at sea.

The article was originally published in the Portuguese language by the *Revista Maritima* about three years ago, but in view of a contemplated reorganization of the Naval School of Brazil the paper was reproduced in French last month.

The attention of Admiral de Jacequay had been attracted to a statement made by M. Jean de la Poulaine in *La Marine Militaire*, in which the writer had affirmed that of all the naval officers of Europe and America, the worst taught in every respect were beyond doubt those of the British navy.

As the admiral points out, the French writer's conclusions were based upon a fallacy, inasmuch as he regarded the theoretical training of the young English officer as completed upon his leaving the Britannia, whereas in actual fact he continues his course of study in seagoing ships, and does not pass his final examination until some four or five years later.

The Brazilian officer, however, goes on to explain that he has no brief to uphold the professional reputation of the English naval officer in particular, but takes as the text of his discourse the statement made by the French critic that "every one recognizes to-day that the officers to whose care are committed the formidable engines of war known as battleships and cruisers, must be men of science as well as seamen." Is this statement right, he asks, or is it wrong?

Conceding the point that in purely scientific matters the officers of the English fleet are worse instructed than those of other navies, Admiral de Jacequay expresses some doubt as to whether this higher standard of theoretical knowledge can be acquired without the sacrifice of a portion of the practical training which is so indispensable to the formation of a perfect seaman. In a short historical retrospect he shows that both in France and Spain schools of higher naval education were established many years before such institutions were contemplated in England, but that in spite of this the English sea officers in the old wars proved more than a match for those of the other two countries combined. And he goes on to observe that even when England established a regular educational system of her own she so far maintained her old traditions as to insist that a sound practical training should stand first, and instruction in scientific subjects occupy but a secondary place. In which, as in many other things, the impartial observer cannot but recognize the sound commonsense of the English nation.

In the course of his admirable paper the admiral deals with many subjects which have been very much before the public of late. He has no sympathy with the theory put forward in some quarters that the executive officer should be able to double his part by assuming on occasion the functions of the engineer. Of what use, he asks, would the most advanced technical engineering knowledge be to the commanding officer who, at the crisis of an action, saw his vessel paralyzed by some injury to the machinery, or the hydraulic machinery of the turret? Are the engineering staff to run to their captain at such a time to consult him as to the best way of repairing the mischief? There were specialists, he continues, even amongst the supernatural heroes of Homer. He who was most skilled in driving the chariot was not the most expert in hurling the spear or in drawing the bow. The system which aims at the production of such "Utopian hybrids" could only have the result of supplying a bad executive officer and a still worse engineer.

The general results of the two systems, the French with its high scientific culture, the English with its more practical training, are summed up as follows: "No one can say with truth that the French officers are better navigators than the English, that in the naval maneuvers the French squadrons prove superior in matters of strategy and tactics, that the discipline and training of the sailors in general are better in the French ships, that the hydrographic work of the French is more perfect than that published by the English Admiralty, which is made use of by other navies all over the world. In administrative capacity, too, the higher officers of the English navy, prove themselves to be in no way inferior to those of other countries."

There is one important fact, too generally left out of account by those who would advocate one Procrustean course of high scientific training for the naval officers, that but a small percentage of the candidates, even when entered by a strict competitive examination, have either the natural taste or the ability which would enable them to follow such a course with advantage. It follows, as is pointed out by the admiral, that after a few years at sea, in a majority of instances, the bulk of the learning acquired in the preparatory course has evaporated, so that the officer retains little more knowledge than one who has passed through quite an ordinary course of nautical instruction. A more elementary course, better assimilated, would, he thinks, form a much more solid basis for the knowledge which a naval officer should possess than a great mass of subjects which only those of more than ordinary ability are able to study with advantage. In the old Brazilian Naval Academy, where the course was but of three years, and the midshipmen passed out at the age of seventeen, many, in spite of their lower scientific attainments, furnished striking illustrations of the naval genius of their country. Whereas at present the course is one of five years, so that the officer does not go to sea till he is twenty-two years old, an age which is much too advanced for the commencement of a naval career.

It would be a great mistake to assume, as is too often the case with foreign critics, that because the compulsory final examination for the rank of lieutenant at Greenwich is fixed at a low standard, no opportunities for scientific study are afforded in the British navy, or that no encouragement is given to such officers as show proficiency in such branches of learning. For the first part of that examination indeed little more knowledge is required than has been picked up at Dartmouth four years earlier, but those who attain a certain standard in the compulsory portion are granted an additional period of study, and should they gain a first-class certificate in the examination held at its close they become entitled to the very great prize of immediate promotion to a lieutenancy. Later in their career, too, from the officers thus distinguishing themselves are selected the lieutenants who are to become specialists for gunnery or torpedo duties, and in this capacity they return to the Royal Naval College for a further course of nine months' theoretical training. Such specialists again receive favorable consideration in the promotion lists to the rank of commander, so that already our admirals' list is very largely recruited from the ranks of the scientific officers.

The distinguishing feature, therefore, of our own system, as compared with that followed in general by foreign navies, is briefly this, that whereas abroad an effort is made to compel every officer to become a scientist, in England we afford special opportunities to those only who are naturally adapted to pursue scientific study with advantage, employing the remainder in practical duties. It is encouraging to find that such a system finds favor in the eyes of an officer in the position of the Brazilian admiral.

The British system of naval education has survived many rude assaults. Some thirty years ago a very strong committee reported that the present method of study at sea under naval instructors was a faulty one and should be discontinued. About fifteen years ago the late Lord Dalhousie, himself a winner of the Beaufort Testimonial as the best sub-lieutenant of his year, denounced it to his brother peers in the Upper House. In spite of these shocks it is still carried on upon the old lines, and as there are at present no signs of deterioration in the quality of the naval officers which it turns out, it will probably continue for some time longer.—*United Service Gazette.*

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.

It is nearly a quarter of a century since the first electric projector was installed on a British ship of war, and yet, so slow is mechanical and scientific progress even in this rapid age, it is still doubtful what design of projector is the best to adopt for naval purposes. In regard to all other departments of a vessel in which electricity might possibly play a part, with the exceptions of incandescent lighting and the working of ventilating fans, there is even more uncertainty in the minds of naval officers and constructors. Experiments are being tried in a tentative fashion in our own and other navies, particularly in the latter; but electrical engineers find it very uphill work to impart their own enthusiasm to those who have to use the apparatus they design. The attitude of the naval officer is very easy to understand. The honor of his flag and his own life are staked on the mechanical appliances by which the ship and armament are handled, and consequently every change involves grave responsibility. The apparatus already in use is accepted, with all its defects and limitations, as part of an established order of things, the use of which carries no blame to any one, even if it sometimes fails to do what is expected of it. In the naval battles of the future breakdowns of machinery will be plentiful enough, due in part to the high-pressure at which it will be worked, but more often to its improper handling in the great excitement of the moment, and sometimes breakdown will entail defeat. A scapegoat will then have to be found, and the officer who recommended the adoption of the device which failed will run an unpleasant risk of filling the position. It is no wonder that such men display a very conservative attitude when called upon to endorse the latest creation of the electrical engineer.

The immense difference between the conditions of peace and war was brought out recently in the discussion before the Institution of Electrical Engineers of a paper on "The Electrical Equipment of Ships of War," by Mr. C. E. Grove, the electrical engineer to the Thames Shipbuilding and Engineering Company, Limited. The author described the hand-regulated lamp of the British Admiralty, and also the motor-controlled lamp used by some foreign nations. Mr. R. E. Crompton took this part of the subject as the text of a severe lecture which he administered to the Admiralty on their want of enterprise, and their inability to appreciate the improvements which scientific men placed at their service, until they were obliged to do so in consequence of the action of other powers. There is, of course, an immense amount of truth in what he said, and the point cannot be urged too often or too strenuously. At the same time it was shown that there are two sides to such a question, when a gentleman from Whitehall read from a report of the operations in the Spanish-American War, that it was found much more convenient to direct the projectors by hand, instead of by the automatic apparatus, as then the beam could be kept more steadily on the object under observation. It must be remembered that in the naval operations at Cuba the shooting was all one side, at least as far as results went, and that the nerves of the American officers were not shaken by the bursting of shells all around them. Under more even conditions of combat it will need a stout heart to stand beside such a tempting target as a projector, in spite of the tradition that it is hard to hit.

In the matter of communication, again, the means which act well when all is quiet, fail entirely in the din of battle. Our vessels are fitted with voice tubes, 2 inches in diameter; but when the guns are being fired, and, indeed, with less violent noises than are produced by artillery, messages cannot be received by them. Loud-speaking telephones are also being tried in our own and several other navies; but it is reported that in the battle of Santiago the Americans found these to be inaudible. As our ships are equipped at present, there is the certainty that messengers will have to be largely employed to transmit orders during an engagement. The position of a captain within a conning-tower will then become very difficult, for until he finds his orders being executed, he will never be certain that the messenger has not been killed before he could deliver them. Mr. Grove suggests the use of a system of printing telegraphs, something after the pattern used by the Exchange Telegraph Company, printing in ordinary letters, as the best method of communicating orders. As 20 to 30 words can be transmitted per minute, and as in addition many orders can be coded or abbreviated, this would furnish a safe and fairly expeditious means of distributing orders, although it is to be doubted whether it would always keep pace with the captain's requirements.

Means for working projectors and for conveying intelligence in a ship are, however, matters of minor interest to the electrical engineer. The subject which attracts him is the distribution of power to various parts of the vessel, and he looks forward to the time when the energy required for the whole of the very numerous machines will be supplied by the dynamos. A first-class battleship carries nearly 100 sets of machinery of various kinds, and a first-class cruiser 50 to 70 sets. With the exception of the guns, all were formerly worked by steam, and most of them are still so worked; although in all new ships the electric motor is finding extended application. The most advanced example in this respect is the United States battleship Kearsarge, just completed, which carries 55 motors, and a generating plant of 350 kilowatts capacity. If this proves a success, it should give a great stimulus to electric driving on board ship, and bring forward for decision the question whether electricity shall not be used in all positions where it is possible. No one would attempt to argue that steam and hydraulic power do not serve their present purposes in the auxiliary machinery of a ship of war, extremely well. Indeed, one may go further and state positively that electric motors will neither raise the boats and anchors nor rotate the hoists more satisfactorily than is done at present. But it by no means follows on that account that the present engines and rams will not be superseded in the near future. They are likely to share the experience of the tank boiler. That was a most reliable apparatus when fairly used, and had a dozen merits which do not pertain to the water-tube boiler. Yet it has been superseded in all the navies of the world, not because it was unreliable, but because a ship is an engine of war, and must be judged as a whole. Speaking generally, no part of a ship is what its designer would desire if he had a free hand. The armor is not thick enough, the guns are not powerful enough, the ammunition supply is scanty, the speed is too low, and the coal supply insufficient. In every particular the authorities have to content themselves with something far short of perfection, for the simple reason that the ship would not float if they put into it all the arms and appliances which they would like to see there. It is just this consideration which, sooner or later, will lead to the use of electric motors in all the auxiliary machinery of a ship. Their employment will save weight, and the displacement thus rendered available can be applied to other purposes.

Electric motors are not lighter than steam engines of corresponding power; indeed, when the generators and their engines are taken into consideration they are distinctly heavier. But they use far less coal than do the small engines they replace, and the saving they effect amounts to a large weight in a week. Mr. Grove calculates that the total motor capacity required on a battleship would be 1885 electrical horse-power, including duplicates, or 1385 horse-power, excluding duplicates. It is impossible to conceive that all this could be operative at the same moment, even in action. Mr. Grove, therefore, puts the maximum demand at a given instant, including 50 kilowatts for lighting the ship and working the searchlights, at 600 kilowatts. He would provide 800 kilowatts in generators and their engines, and these with steam and exhaust connection would weigh about 80 tons. The weight of the motors would be about that of the engines they displaced, if the saving that would be effected by the substitution of electrical machinery for hydraulic appliances for gun working be reckoned in. Against the weight of the generators and their engines is to be placed that of the main hydraulic equipment of about 25 tons which would be saved. There would also be a slight saving in the weight of the distributing cables and switchboards as compared with the auxiliary steam and exhaust pipes now used. Approximately 55 tons of additional weight would have to be carried, and this can only be economically done if a proportionate saving in coal can be effected.

It is very difficult to say what amount of coal is used by the auxiliary machinery on board ship, but undoubtedly it is very great, the condensation in the steam pipes alone accounting for a great amount of fuel. Sir John Durston, in his paper on the trials of the Diadem (see *Engineering*, vol. lxv, p. 444, April 8, 1898), stated that to run one main feed pump, one blowing engine, one auxiliary circulator, one electric-light engine, and two distillery pumps consumed coal at the rate of 6.1 tons per day, when two extreme forward boilers were used, or 3.88 tons when two extreme after boilers were employed. The same machines, with the addition of two evaporators, working compound, consumed 8.8 tons of coal per day when supplied by the forward boilers, and 7.09 tons when supplied by the after boilers. That is the length of steam pipe between the forward and after boilers accounted for 2.12 tons of coal per day in the first trial, and for 1.71 tons in the second. What the loss is when really long lengths of steam pipe to the forward and after capstans, and to the steering gear, are in operation has never been determined as far as we know, but evidently it must amount to several tons of coal per day. Again, it has been found that in the Japanese ironclad Shikishima it takes from 3½ to 5 tons of coal to run for 18 hours a day an engine of 65 indicated horse-power situated 160 feet away from the boiler, the total range of steam pipe connected being 500 feet to 600 feet. This works out to from 7 lbs. to 10 lbs. of coal per indicated horse-power, of which more than half must have been used in keeping the pipes warm.

The consideration of such figures as these, somewhat rough though they may be, endorses the belief that the auxiliary machinery of a battleship, steaming at one-fifth power, accounts for about one-fourth of the coal consumed, say 20 tons a day. Sir John Durston, in his paper before the institution of Naval Architects (see *Engineering*, March 31, 1899), put the figure at 22 per cent when the main engines were giving 3600 horse-power, and this was on a trial in which everything was working at its best. It seems, therefore, reasonable to hope that something like 10 tons of coal might be saved every day a ship was at sea if all the auxiliary machinery could be driven electrically. Thus, by adding 55 tons of machinery to the ship, the coal consumption would be reduced 10 tons a day, or about 12 per cent at economical speeds. In other words, some 200 tons of displacement would be rendered available for other purposes, such as increased speed, greater radius of action, heavier armament, or thicker armor.

The time is not yet ripe for such a radical change in the equipment of our ships of war; but there is no doubt that the change will come in the near future. It is, however, one of those alterations of which the great benefit cannot be reaped until it is adopted entirely. It is only when a clean sweep is made of long steam pipes, and a properly designed dynamo-room, second in importance only to the main engine-rooms, is provided for in the original design, that full economy will be attained. The greatest obstacle to progress at present is the steering engine. It is a very bad steam eater, and we are not yet in sight of a satisfactory plan of operating it by electricity. The regulation has to be so minute and so absolute, and withal capable of being effected from so many parts of the ship, that the problem bristles with difficulties. Again, the subject of gun-training by electricity is far from simple. M. Canet has attained a considerable degree of success, but to do that he had first to carefully balance his turrets so that they moved with far less than the accustomed efforts. He was fortunate that he could do this, because he occupied an important position in the company which constructed the guns. Most inventors would find that the interests of the firms supplying the artillery did not lie in the direction of introducing refinements to eliminate friction. Nevertheless, in spite of difficulties of many kinds, substantial progress is being made, and each year sees electricity playing a more important part on ships of war. But, just as it is rapidly displacing line shafting and belts on shore, so it is destined to take the place of long steam pipes and hydraulic mains on naval vessels, until some day naval engineers and officers will wonder how they endured the heat and mess of the present system, while constructors will thankfully accept the displacement thus rendered available for other purposes.—*Engineering*, May 11, 1900.

WIRELESS TELEGRAPHY IN WAR.

A correspondent of the *Electrical World and Engineer* writes to that journal as follows:

When Signor Marconi was in the United States last fall he had the opportunity of testing his wireless telegraphy at the yacht races for the America cup, and the success obtained then in times of peace induced him to remark, "I'd like to try the system in a war." His second visit to this country now comes after an interval of six months of severe fighting in South Africa, where his system of wireless telegraphy has been in use on land and sea. The test in time of war has proved even more interesting and important than in the international yacht races off Sandy Hook.

Signor Marconi did not go to South Africa personally, but several of his assistants went there with several outfits of wireless telegraphy, and they operated in conjunction with the fleet patrolling the coast. They confined their attention exclusively to sending messages between the several warships and between the fleet and the shore. At Delagoa Bay the British admiral sent messages a distance of 80 miles to the fleet off shore. The British battleship Hannibal also sent and received messages to and from the battleship Jupiter, when under way, over a distance of 32 miles. One message was sent 100 miles, the greatest distance successfully covered.

While there were none of his assistants with the land forces in South Africa, his system of telegraphy was used by Lord Roberts and a modification of it by General Baden-Powell. Generals White, Buller and other English officers did not take kindly to the new invention, and instead of using the instruments sent to them for all they were worth, they relied upon the old-time heliograph. It was this prejudice against the new invention that kept wireless telegraphy so much in the background during the early stages of the campaign, and it is possible that it would have received scant notice in the South African compaign had not Lord Roberts assumed command. He was not a kind to keep anything that would serve his purpose in the background simply because it had never been tested in the past. Upon assuming command in South Africa he summoned a body of wireless telegraphers and kept them in his camp all through the struggle. These experts kept him in touch with the various units of his enormous army, and some of the messages were sent overland a distance of 60 miles. There are ten sets of instruments in Lord Roberts' army, and these have been developed successfully. All scientific questions and experiments made by a rapidly moving army are of necessity scantily reported by a commander in the field, and the accounts of the tests with the wireless telegraphy are still quite vague.

One important improvement in the system in war times was made through the co-operation of the hero of Mafeking. The difficulty of sending messages any great distance in a mountainous country like South Africa was overcome by the invention of a system of kites by Baden-Powell. In order to make wireless telegraphy successful it is necessary to raise the wire attached to the instrument to a considerable distance in the air. Thus to telegraph 60 miles the elevation of the wire should be at least 100 feet above the surface. It was often impossible to find any way to secure this altitude for the wires, but by using the kites the problem was easily solved. Kites of the Baden-Powell type consequently became inseparably associated with the wireless telegraphy in South Africa, and it was by this means that messages were sent a distance of 60 miles.

Signor Marconi expressed himself satisfied with the experiments made in the war, and so far as the reports have been received, they are nearly all favorable in their results. Both the British and Italian navies have adopted his system, and others are experimenting with it for the purpose of using it should it prove satisfactory, including the United States navy. In the meantime some of the big transatlantic steamship companies are using the system, and one of the inducements offered their patrons is of communicating with friends on shore long before the steamers reach port. Several hours are saved in this way on both sides of the Atlantic in receiving the latest news of the day which may have transpired on two continents while the passengers were on the sea.—*The Iron Age*, Aug. 23, 1900.

SUBMARINE CABLES IN PEACE AND WAR.

The operations now going on in South Africa have probably brought home to most of us, more forcibly than was ever the case before, the immense importance of that system which, having its center in England, embraces the whole globe in a vast network of ocean cables. The troops are acting at a distance of 6000 miles from our shores, yet, day by day, when there is no intervention of the censorship, we are kept informed of the proceedings with almost as much ease and minuteness as if the operations were taking place in the Long Valley at Aldershot. So that it may fairly be regarded as a matter of self-congratulation that this great undertaking was established by English enterprise, that the necessary funds were provided by English capital, and that the whole system is practically under the control of the Englishment government.

The cables, indeed, are in no sense government property, except that in certain cases, where the value is clearly more strategic than commercial, a certain subvention is made from the public funds. But in granting the concessions which permitted the construction of the several cables, Parliament has so fettered the action of the companies by salutary restrictions that the cables at periods of crisis are as much at the disposal of the government as if they had been paid for in the first instance out of the public purse. It is provided, for instance, that government messages should have precedence over those of the general public; that no employee of foreign nationality should be allowed upon the staff; that in time of war the government should be at liberty to substitute its own people for the regular staff, and so forth.

The pecuniary benefits resulting from a commercial monopoly such as this are sufficiently obvious. As has been well said by a foreign critic, by means of her cables England renders all other nations tributary to her. And the political advantages are not less marked than the commercial, for the possession of the cables affords the opportunity of acquiring early and exclusive information of events happening all over the world, information which now and again may be of the highest value.

But if the control of the world's ocean cables is an important matter in time of peace, its significance is increased tenfold in case of war, and more particularly in the case of a naval war, and this fact is becoming very generally recognized. Not long since the American *Boston Globe* made the following remarks upon the subject: "Of all the lessons that the United States ought to be learning from the Transvaal war, the chiefest is that any nation aspiring to be a first-class sea power in the coming twentieth century must control the submarine cables as well as the fleets. Why does Britain rule the waves to-day? Is it alone because she owns the biggest fleets, or is it because, owning the bulk of the submarine cables of the world, it makes every British battleship worth five ships of the enemy who is destitute of them? The power that is to rule the waves must rule the cables. If England is master of the seas it is largely because of her great silent empire under the seas."

In any naval plan of campaign directed against this country, some scheme for cutting the more important cables must necessarily find a place. In a work published in France under the title of "La Guerre Navale avec l'Angleterre," which was recently discussed in these columns, the author considered that with the aid of ships furnished with the necessary special appliances for cable-raising, the operation, though one of some delicacy, would not be very difficult. A German officer, Major Otto Wachs, who has also been writing at some length upon the same subject, and whose paper, translated by a young French naval officer, was published in a recent number of the *Revue Maritime*, takes a less optimistic view of the subject. Major Wachs is of opinion that although the International Conference of 1882, which fixed the inviolability of the cables in peace time, permits them to be cut in time of war, the task of raising and cutting the cables would be found a somewhat difficult one in practice, partly on account of the motion of the sea, and partly because operations would be forbidden by international law in the neighborhood of a neutral coast. For the difficulty both of finding and of raising the cable would be obviously very greatly increased by the additional depth of water in the open sea. Some of the major's concluding remarks are perhaps worthy of reproduction. "It seems a remarkable example of the irony of fate," he writes, "that this England—at whose feebleness everyone makes merry—has succeeded, not as the result of a happy stroke of luck, but as the merited reward of a great work peacefully accomplished, in encircling the world by means of her cables, and making the entire globe her tributary, for not only does she throw every obstacle in the way of other nations who attempt any great enterprise, political or commercial, but contrives to make them pay the interest of the capital embarked in submarine cables, while she has created at their expense an admirable instrument of power in the event of international complications destined to find a solution in war. If we listen with a smile to the story of their desperate efforts to maintain supremacy, by building a fleet of the first class, made up of superb vessels, for which they have neither officers of experience, engineers, or sailors, one cannot refuse one's admiration to this gigantic work, which consists in establishing submarine cables, for transmitting from distant stations, thanks to such centers as Malta, the Azores, Bermuda or Seychelles, to headquarters in London, swift messages, commercial, military or maritime, which are only communicated later to other powers interested."

It may be remarked in passing that the taunt here levelled at us that in the development of our fleet the *personnel* has failed to keep pace with the *matériel*, has some basis of fact. We have, indeed, provided ourselves with a number of the most up-to-date powerful vessels, while still lacking an adequate supply of crews to man or of officers to command them.

Such a state of things, unsatisfactory and anomalous as it appears, is to some extent unavoidable, since, while it is possible by working overtime in the government yards, and by putting pressure on the private contractors, to turn out new battleships and cruisers in what is a relatively short period of time, the training of the sailors, and still more so of the officers, must always be a matter of several years. As was said by Admiral von Tirpitz the other day during the debate on the new navy budget in the German Reichstag, "We cannot conjure up officers and seamen for the additional ships by a stamp of the foot." The entries of officers, both of the executive and engineer classes, have been largely augmented of late years, and we are already beginning to reap the advantage of this policy, while the number of seamen is also each year becoming more nearly adequate to the increased needs of the fleet. Meanwhile, in the practical monopoly of the world's cable system, this country possesses an asset which is admitted on all sides to be of the very greatest value. It rests with the authorities, and more particularly with the department specially charged with the supervision of all matters relating to the ocean cables, to see that no precaution is omitted which would ensure their integrity and efficiency in the unfortunate event of the outbreak of a naval war.—*United Service Gazette.*

CORDITE AND ENGLISH GUNS.

There are at Woolwich just now two Elswick guns which may prove valuable in the inquiry that is to be conducted on the cordite question. These guns were purchased since the war began, and are not of the service type, being 6-inch guns of 50 calibers length, with enlarged powder chambers of curved form approaching the oval in longitudinal section. They differ also from service guns in their obturation. In the Weling or Vickers system the pad presses against a conical bearing. This no doubt facilitates forcing a pad tight with pressure behind it, but at the moment of firing, when there is a tremendous pressure in the opposite direction that is backwards against the front of the breech-plug, any yield has the disadvantage of bringing the plug into a larger part of the cone where it has play round it. These two guns have the bearings for the pad in one case cylindrical, and in the other partly so. This, however, is a question to be considered on its own merits, and does not touch the main point which we have in view; namely, the powder question. One of these guns has been used for experimental firing, and has shown much less corrosion than is usual for the number of rounds fired. The increase of length naturally gives an advantage, our longest service pattern being only 45 calibers in length; the enlarged chamber, however, is of greater importance. We believe that a muzzle velocity with a 100-lb. projectile of 2500 foot-seconds, has been attained with a pressure of something like 12 tons with cordite. On the other hand, an enlarged chamber gives room for a milder explosive requiring a greater volume. An enlarged chamber is a device that ought specially to be available for us, because our wire-bound guns have great tangential strength, of which we have hitherto failed to get the full benefit.—*The Engineer*, June 22, 1900.

ACTION OF EXPLOSIVE SHELLS ON SHIPS.

We print elsewhere a letter signed "X." We wish that we could give the name of the correspondent, for it is one that would carry great weight. However, it is of the less consequence because we write chiefly for those who can judge—at all events, to some extent—of the value of opinions and statements without requiring to know the names of the writers. There is hardly a more important question connected with war material than the action of shells containing explosives fired against ships. Such are the possibilities of shell fire, that it may be said the liability to sudden destruction from well-delivered shells has existed as an element in naval warfare since the days of Sinope. Santiago brought this prominently forward again. In fact, it appeared as if ships containing wood which shells could reach would quickly share the same fate as the Spanish cruisers. That is to say, that they would take fire and burn with a fury that very probably could not be grappled with under fire. Hence it appeared as if Germany had stolen a march on us all in banishing wood from the hulls of her warships; nevertheless, there were certain reasons for discounting the apparent conclusions drawn wholesale from the fate of the Spanish cruisers. For example, the Spanish wooden decks had no iron below them, thus the wood composing them was very freely exposed to the action of air, which would encourage fierce conflagration. Thus it was clear that wood inside even medium armor was in a very different position from unprotected wood, because little except dead metal would reach the former, and that generally from armor-piercing shells only, whereas every projectile from every caliber of gun might successfully attack the wood of the Spanish cruisers. Solutions also exist which render wood non-inflammable, at all events, for a time, so that while it was right to study carefully the lessons to be learned from Santiago, there was no cause for serious alarm. Putting alarm, however, out of the question, a revolution in the application of wood is fairly serious, so that the Belleisle experiments were looked to as specially needed to settle the question of ship's liability to take fire under shell attack, and the fact that the timber did not burn, as prophesied by some, was considered so satisfactory that in a great measure secrecy was abandoned, and the vessel thrown open to examination, as soon as it was found that she had not been set on fire. We have expressed the opinion that many valuable experiments might have been tried in detail on the Belleisle before she was subjected to wholesale destruction, and we still adhere to that opinion. We believe, however, that the great importance of the incendiary trial provoked impatience, which did not brook of the delay necessary to test such questions as the individual action of various shells on the structure. This being so, we have to make the best of the state of the vessel after the general attack to which she was subjected.

It may be said, we think, that the question next in importance to the incendiary one is the value of high explosives compared with powder. As most of our readers are aware, common shells of two kinds are employed in the service. Pointed common shells charged with powder, entered by means of a fuse hole in the base of the shell, to which the fuse is afterwards fixed, and common shells with nose fuse holes charged with lyddite. Shells of the former class are calculated to penetrate and carry their bursting charge further into the structure attacked; those of the latter class produce a more violent effect as they enter. Opinion has been divided as to the relative value of these shells. So far as the Belleisle results can be judged, the shells with high explosives are far the more efficient. Even in power of penetration, the pointed shell have proved disappointing. A pointed projectile which retains its shape drives its point through armor, and literally bores a hole, forcing the metal radially from the center, which is generally the easiest way of making a hole. Supposing the armor, however, to defeat this, and to flatten or break the point, the projectile only gets through by driving a disc of plate out in front of it, and this is better effected by a blunt projectile than by one that has wasted some of its energy in a futile attempt at boring. Some impressions on the side of the Belleisle show that this action only left feeble impressions on the ship's side. In short, armor, as it is now made, keeps out shell fire comparatively easily; and it is desirable to have no compromise, but to use either the form of common shell proper, which produces greater results on unprotected structure, or the strong armor-piercing shell, which alone can get through even the plates of moderate thickness—say, 5 inches—which are being applied more and more extensively on ships' hulls, shot also are required, but for belt attack only.

As pointed out in our correspondent's detailed report, there is no comparison between the destruction caused by lyddite and that resulting from the use of black powder, and now that it appears that conflagration is not brought about as was supposed, by lumps of burning powder projected and lodged in the woodwork, it seems as if the pointed common shell might be discarded with advantage, though we confess to the wish to see a few strictly comparative experiments with each class of projectile. "X." has criticised our correspondent's mention of the upward action of lyddite. We concur with "X." in recognizing that at the moment of explosion the forces in action are too vast to be sensibly affected by gravity, and practically action is developed equally in all directions, finding its principal escape in the direction of least resistance. This will, however, often be upwards, also when the first explosion is over, the subsequent rush of gas is upwards, while air rushes in laterally from all sides to take its place. This causes windows to break towards the point of explosion, and gives evidence of an upward rush which may be confused with the primary action of explosion. So far the main lessons of the Belleisle experiment are rough and general, although no doubt important, namely, that wood may be applied so as to be very little liable to catch fire, that common shells with nose fuses and high explosives are best for unprotected parts of the hull, while armor-piercing shells are needed even for medium armor. A second set of conclusions are those connected with chances of hitting upon, which we do not here touch. We trust that the Belleisle will yet be utilized to exhibit the particular effect of single rounds fired under various conditions.—*The Engineer*, July 29, 1900.

OUR BATTLESHIPS IN THE LIGHT OF THE BELLEISLE EXPERIMENT.

The very remarkable test of the Belleisle recently carried out by the British Admiralty is particularly gratifying to naval experts in this country, for it goes to prove that the principles upon which the ships of the United States navy have been designed in regard to their defensive qualities are thoroughly sound; in other words, that the emplacement of guns and the distribution of armor are better suited to resist the attack of modern high-power guns than that adopted by those navies which must be regarded as possible antagonists. The principle underlying the defensive arrangements of our vessels is that the best protection against shell-fire is the provision of a continuous, vertical wall of armor from below the water-line up to and embracing the gun-emplacement. Thus, in the battleships of the Alabama type, we have from 9½ to 16½ inches of armor extending from below the water-line to several feet above it; then the 15-inch wall or barbette armor, and above this the 14-inch protection of the turrets; while for the 6-inch guns of the intermediate battery we have 6 inches of armor from the belt to the deck upon which these guns are carried, and 5½ inches of protection in front of the guns themselves. Now 6 inches of armor will, in almost every case, burst a shell on its outer surface, or at least before it can effect an entrance within the vessel.

Turning now to the account of the damage done by the guns of the Majestic upon the Belleisle, it will be noticed that the 6-inch shells which struck the armored portions of the vessel failed entirely to penetrate, the lyddite shell being in this respect as helpless as the common shell. On the other hand, whenever they struck the unarmored portions of the ship, they passed through and burst between decks, with the result, in the case of lyddite, that the deck was lifted over a wide area, and that portion immediately over the explosion completely blown away. Now, it has always been contended by Sir William White, the very able Chief Constructor of the British navy, that high-explosive shells which burst between decks would act exactly in this manner, and that it was absolutely imperative to provide a complete wall of side armor, of sufficient thickness to keep out a high-explosive shell, which should cover each gun-emplacement and extend without a break from the gun-platform down to and below the water-line. This principle has been faithfully followed in all the battleships and armored cruisers of the modern British navy, and, with the exception of the Maine and the Texas, the same principle has governed the construction of the battleships of our own navy.

To appreciate the value of a continuous wall of vertical armor from water-line to gun-emplacement, we have but to look at some of the most notable of the German and French designs; such, for instance, as the three French battleships of the Charlemagne class, and the four German battleships of the Kaiser Friedrich III class. In every one of these seven first-class battleships there is a wide gap, extending over a height of two decks, say about 15 or 16 feet, and reaching horizontally the whole length of the vessel, upon which there is not an inch of armor protection. In the case of the Charlemagne, although the eight rapid-fire guns on the main deck are protected by 3 inches of armor in front, they have nothing but the thin shell of the vessel to prevent high-explosive shells from being burst within the vessel immediately below the deck on which they are mounted. This shell plating would serve simply to give the shock necessary to explode the shell at the point where it would do most damage. The way in which the decks of the Belleisle were blown to pieces suggests that in a duel at moderate range between the Charlemagne and, say, our own Alabama, the seven 6-inch rapid-fire guns which the latter would be able to bring to bear, to say nothing of the 12-inch rifles, would, if firing high-explosive shells, very quickly put the whole of the rapid-fire battery of the Charlemagne out of action. This will be readily understood by referring to the armor diagram of the Charlemagne, published in our article on the French navy (*Scientific American*, January 28, 1899).

The same serious defect exists in that otherwise admirable ship, the Kaiser Friedrich III, in which, the guns although emplaced in separate turrets, and well protected from what we might call lateral or horizontal attack, have no protection against the bursting of high-explosive shell beneath them, other than is afforded by a small armored ammunition tube extending from the base of the gun to the protective deck some 15 or 16 feet below. Well-directed shell would pass through the unarmored sides above the water-line belt, and could be burst in great numbers beneath the floor of the turrets. In the Kaiser Friedrich III this is true, not only of the rapid-fire battery, but of the two turrets containing the main armament of four 9½-inch guns. A diagram of the Kaiser Friedrich III appears in the article upon the German navy, *Scientific American*, April 22, 1899. If the diagrams of these German and French ships be compared with those of such vessels as the Oregon, Kearsarge, Alabama and the Maine, it will be seen at a glance how vastly better equipped for defense are the American ships than those of France and Germany.

Upon the other hand, it is only fair to state that the continental navies, notably the French navy, have shown their farsightedness in adhering to the continuous, as against the partial, belt at the water-line. Both the Charlemagne and the Kaiser Friedrich III have a belt extending practically throughout the length of the vessel; whereas the Oregon and her class, like the Royal Sovereign and Majestic class of the British navy, have only a partial belt extending for two-thirds of the length of the vessel amidship. Judging from the Belleisle results, shell-fire would tear these unarmored ends to pieces, admitting water and injuring the stability of the vessels. Our later ships, however, of the classes named above, are to have a practically continuous belt, and will be in this respect a great improvement over the Oregon.—*Scientific American*, July 21, 1900.

EXPERIMENTS IN TEMPERATURE OF EXPLOSIVES.

In a communication recently made to the Royal Society, Messrs. Macnab and Ristori, continuing their researches upon modern explosives, give an account of a series of experiments to determine more exactly the temperature reached by explosives in a closed chamber. Previous experiments have shown that a thin platinum wire is melted by the heat developed during the explosion, while a thick wire is unaffected; this proves that the temperature exceeds the fusing point of platinum, but the duration of the maximum is very short. The experimenters use for the purpose a thermo-electro couple of rhodium and platinum wires having different diameters, and thick enough not to be melted by the explosion. The deflection of the galvanometer would then vary in inverse ratio to the thickness of the wire forming the couple, and it would then be easy to calculate the deviation which would be caused by a couple infinitely small which would absorb all the heat in a time infinitely short; this deviation, expressed in degrees, would represent the temperature reached. In the experiments a series of thermo-electric couples formed of wire of platinum and an alloy of platinum with 10 per cent of rhodium were used, whose diameter varied from 0.25 to 1.1 millimeter. Each couple was successively fixed in the interior of a shell, and the deviation of the galvanometer was registered by the photographic method. It was thus found that guncotton is the explosive giving the lowest temperature; then follow in order cordite ballistite (70 per cent fulmicotton with 30 per cent nitroglycerin), then another form of ballistite, with equal parts of cotton and nitroglycerin. The experiments are now being made to determine the elements necessary to convert the deviation of the galvanometer, expressed in degrees, into degrees of temperature.—*Scientific American*.

THE BELLEISLE EXPERIMENT.

It is very rash to attempt to review an experiment of which the circumstances are kept secret, more especially when it is conducted by authorities as capable as those at the Admiralty. We do not, therefore, now attempt to review the trial conducted last Saturday in the usual way, but only to notice the results that were necessarily known, and to consider how the matter must present itself to those outside the very limited number of persons who had access to the exact objects in view, and the precise results produced. Limiting ourselves in this way, we shall be justified in expressing our opinion freely.

The actual operation, as our readers know, was the destruction of the Belleisle in five, or we may say, in three minutes, by the Majestic, though the firing continued for 9¼ minutes in all. The Belleisle is a cross between a central-battery ship and a coast-defender. She was built for Turkey, and purchased by us in 1878. She has a belt and central battery, with wrought-iron armor from 12 inches to 6 inches thick, but nearly three-quarters of her hull above the belt is unprotected. This structure the Majestic attacked with her four 12-inch guns and her broadside batteries of 6-inch quick-firing guns—six on each side—and her lighter guns. Speaking generally, no one could doubt as to the result. The Belleisle could not fail to be "riddled and gutted" in a few minutes. To the uninitiated a most costly and invaluable target was apparently destroyed, and the goose that might have laid the golden eggs killed with a vengeance. We refuse to believe that there was not something more than this behind, but we think it a pity if some statement to this effect is not made by the First Lord, for this is how the matter must present itself to the public.

Even as the trial is reported, however, there is something to note. First as to accuracy of fire. The Majestic opened fire at 1700 yards' range while steaming at 6 knots an hour, with a 12-inch gun, which entered the stern of the Belleisle, raking her, if we are to believe the reports, and emerging at her bows. This we regard as admirable, for it was necessary for the Majestic gun to be laid correctly and got off almost exactly when the line of the Belleisle keel coincided with the line of sight. The projectile must have traversed the length of the ship, passing through the armored bulkheads or walls without serious deflection. We hail so good a shot, specially at the present time. Very able criticism of the American firing at Santiago has resulted in one case in the conclusion being arrived at that the disturbing causes in that action were so great, and the resulting probable error found by working backwards so erroneous, that it was quite a matter of indifference what the shooting of the guns was, and that the difference between the most hopeless old smoothbore and the best rifled gun would have been nothing to signify. We have always held that at Santiago the circumstances were just those which must cause, and indeed justify, wild shooting. A group of ships after the monotony of weeks of watching suddenly see an enemy moving out and making away at four miles range from most of them, an enemy who ought to have the heels of them. It was a case when the only apparent chance was to fire at once and chance a hit at the cost of great waste of ammunition. Subsequently, when the Spanish speed proved deficient, and when the American ships were gaining on them, the chances greatly improved. Had they attained to racing abreast of them, which hardly happened before the Spanish cruisers were destroyed, it would have been easy to direct a discriminate fire attack; but as it was, the whole engagement was a wild, unexpected race. The Majestic's first round shows what can be done by the heavy guns of a vessel steaming at six knots, and availing herself of a chance which could only present itself for a moment. The shell attack which followed was apparently well directed, but in present circumstances we learn little from it. The destruction at Santiago, however, emphasizes the fact mentioned by the First Lord apparently as the leading one in the Portsmouth trial; namely, the circumstance that the Belleisle did not actually take fire. This, if wholly instead of partially true, is very important. In the German warships all wood has been condemned and dispensed with for some time past; the experience at Santiago seemed to show that we had lost much by not doing the same. If, however, wood can be protected by any means, things are not quite as was supposed. Apparently, water was very freely used in the Belleisle. However, on this we may hope to hear more shortly.

Nevertheless, we think that the programme was disappointing, although the results were as good as such a programme might offer. We should have liked to have learned the effect of individual rounds of various kinds, even if the experiment was to terminate in wholesale destruction. Even as concerns wood itself, it is important to know how wood behaves when behind armor, as compared with its application to unprotected parts of the ship. First, can shells carry fire through armor so as to ignite wood inside it? Secondly, can wood be rendered non-inflammable by any composition without drowning it with water? Thirdly, what is the incendiary power of powder compared with lyddite? Fourthly, what is the poisonous effect of the gas generated by lyddite or similar high explosive? Then we should have wished that a casemate could have been constructed, and the liability of gas elsewhere to enter tried. For all these it would be necessary to fire single rounds and examine closely. If this is thought tedious, it might have been conducted by specialists only, without interfering with the operation of general destruction at the end, if desirable. In short, we hoped that much experience in detail was going to be obtained from this grand target, for in speaking of the incendiary power of common shell we have only dealt with one branch of the subject. There is a question of the penetrable action of the shells, of their behavior when burst by a quick fuse before they are broken by the shock of impact, compared with that of a fuse which allows the shell to be broken and then burn its powder after rupture, effects which were brought out by the Shannon experiments. The extraordinary breaking up into minute fragments of Palliser shells, which is liable occasionally to happen, as in air-space targets, has never been satisfactorily explained. Above all, we have always hoped for a trial of a powerful projectile passing through the decreased belt armor now adopted and impinging on the inclined deck armor behind it. What is likely to happen on deck above? This would call for a section to be specially made, and no doubt such a section might be made on shore; but when we are testing the effect of fire on ships' structures with an actual ship, it seems worth while operating a little more, and testing the question of structure as far as possible.

We are bound to admit, however, that not only are we completely in the dark, but that some statements add to the depth of that darkness. For example, we are told "Some 9-inch Krupp plates had been temporarily placed over the citadel and were fired at by the 6-inch guns. Though these were tested, none were penetrated. The trial, therefore, demonstrated the value of the armor now in use." This could not be seriously said, and yet if this sentence was put forth to convey the impression to our continental powers that we are idiots, we think it is overdone, for we might just as well throw snowballs at Krupp 9-inch plates as 6-inch common shells, or for the matter of that 6-inch projectiles of any kind under service conditions. We imagine that the 9-inch Krupp plates were more likely to be intended to try what the 12-inch projectiles would do against them, 9-inch hard-faced plates constituting the vertical armor belt of the Majestic herself and her class, reinforced by inclined deck armor. If this, however, were intended, why was not the 12-inch gun fired so as to hit the 9-inch plate? We mean, why was not a deliberate experiment arranged, as we have said above, to test the belt?

In short, while we believe in our construction officers and our ordnance officers, and while we do not doubt that valuable results must be obtained from the Belleisle trial, at the present moment the question, like the vessel herself, may be described as enveloped in the thickest smoke.—*The Engineer*, June 1, 1900.

A RUSSIAN VIEW OF SEA POWER.

The *Novoe Vremya* has recently been the field of a discussion on sea-power, or the meaning of a fleet. As is well known to the readers of the *United Service Gazette*, the policy of the *Novoe Vremya* is that Russia should build only torpedo-boats and submarine vessels to defend her coast, with cruisers to annoy the commerce of her enemy, which from the point of view of the *Novoe Vremya* is England. Quite unexpectedly an article in the *Novoe Vremya*, entitled "International Understandings," has raised a hot argument on the above subject. The article, which caused such a flow of diverse opinions, was initiated in the office of the *Novoe Vremya*, and was, therefore, necessarily hostile to England. Regret was expressed in this article that there was no international tribunal before which England could be arraigned, and forced to deal more lightly with the African republics. The Russians are recommended not to deceive themselves and imagine that the millennium is about to commence. On the contrary, it is evident from England being quietly allowed a free hand in Africa that we are passing through an era of indifference and contempt for the spiritless or the weak. Why has no power interfered between England and her prey? The reply given is, because England is too powerful at sea.

The article asks, "What bounds will England place to her self-conceit and her daring?" England not only considers it her duty to mix in every political question, but expects to have the deciding vote in all parts of the world; in fact, to become the Paramount Power. On every dispute England threatens her adversary or her rival with her mighty fleet.

This article drew an answer from General Riraeff. Remarking on the observation, already mentioned, that England considers international law a mirage, the general adds that the *Times* also is jeering at Russia for having listened to the behests of Europe at the treaty of Berlin, and observes that England will arrange her own matters without consulting other opinion, and in her own method. The article continues regretfully that no one can interfere with England in this matter, but, nevertheless, believes that a fleet is absolutely unnecessary for Russia. The gallant general considers a fleet wholly unnecessary for Russia because, he argues, the only two nations with which Russia is likely to go to war are England and Germany. A war with Germany, the general holds, would be decided on land, and although the Russian fleet might bombard Kiel or Dantzic, or the German fleet bombard Riga or Libawa, still this action would have no effect on the result of the war.

It is pointed out that the French fleet, although much stronger than the German, had no effect on the war of 1870-71. In case of war with England, Russia's ironclad fleet would be still less useful. For however many ironclads Russia built, England could always build two to Russia's one. But there is another way in which England can be acted on, and that is through India. General Riraeff considers that the best way for Russia to meet England is not to spend money on a fleet, but to prepare a scientific advance to India, and to coerce England through India. "Are not we (Russia) stronger than the United States, and is not India more valuable than Canada?" are the concluding words of this article. General Riraeff's paper is answered by "Nauta," who first challenges the general's view that the French fleet did nothing in the war of 1870-71 because a fleet could do nothing. "Nauta" holds that the French fleet was as badly directed as was the French army in that war, but had suitable ships been sent the results of the war might have been different. "Nauta," continuing, points out that although suitable strategic railways may be built, and mobilization perfected to the last degree, yet a fleet will always be able to land an expeditionary force on the coast and seize the required position before the defending force can arrive by train. Even in the face of a defending force, already assembled a fleet, owing to the power of its artillery, can land an expeditionary force. This is an opinion held by many Russian officers in high positions. "Nauta" also asks if Russia is without a fleet, what will happen to the islands and peninsulas on the Baltic coast and in the Gulf of Finland?

Is it only with Germany and England, asks "Nauta," that Russia is going to quarrel? What about Japan, Turkey, Italy, Sweden, and America? Have we concluded a lasting peace with these nations? In a war with Germany is Russia to leave Germany's colonies and mercantile fleet untouched? Russia would be very chivalrous if she did so, and the Germans would probably consider her very silly. Without doubt, the German navy and mercantile marine would be used to the utmost against us.

As regards England, "Nauta" agrees with General Riraeff that the Russian fleet of the present day would not be able to play any higher rôle than it did at the time of the Crimean war. Therefore the safety of the Russian shores must be provided for by torpedo and submarine boats, and the offensive taken by large cruisers attacking English commerce. Neither does "Nauta" believe in the use of a descent upon India. For suppose that Russia took India, what could she do with it? India has been taken before by Alexander of Macedon, by the Dutch, by the French, but none of them have been able to retain it, and should we (Russians) be any better able to hold it? Sooner or later England would recover India by means of her fleet, by means of money, or by intrigue. It is very evident that the population of two hundred millions is not controlled by force alone; such a multitude could not be kept in slavery by 100,000 soldiers. The fact is that England governs her 200,000,000 subjects by intelligence and tact, not by force. Could we Russians in the same way manage different nations and castes so that they would be as obedient to us as they are to the English? It is doubtful. We Russians have our own work in the world, therefore it is better not to meddle with England, who fears nothing, and laughs at all, having, it is true, an insignificant army, but a mighty fleet.—*United Service Gazette.*

INCREASE OF OUR NAVY SINCE THE SPANISH WAR.

A request from a subscriber for a statement of the new vessels that have been authorized for our navy since the publication of the *Scientific*

American Navy Supplement, suggests to the editor that this information will be generally welcomed by those of our readers who include the *Navy Supplement* in their files.

Battleships.—Beginning, then, with the battleship class, we have the Maine, Missouri and Ohio, authorized May 4, 1898. They are of 12,300 tons displacement and 18 knots speed; are protected with 11-inch armor on the belt, and 12-inch on the barbettes and turrets; and will carry four 12-inch B. L. rifles and sixteen 6-inch rapid-fire guns besides twenty-six 6-pounders and automatics.

Following these come the ships of the Georgia class, the Georgia, New Jersey and Pennsylvania, authorized March 3, 1899. These vessels are to be of 14,650 tons displacement and 19 knots speed. The belt will have a maximum thickness of 11 inches, and the gun positions will be protected with from 11 to 6½ inches of armor. After lengthy discussion, it has been decided to provide these vessels with the double-deck turret, arranged as in the Kearsarge, and the armament will consist of four 12-inch and four 8-inch B. L. rifles; fourteen 6-inch and twelve 3-inch rapid-fire guns, besides thirty 3-pounders and machine guns.

The present Congress has recently authorized the construction of two more battleships of equal size, to be known as the Virginia and Rhode Island. In them a return is to be made to the turret system of the Oregon and Iowa, the intermediate 8-inch battery being mounted in four separate turrets at the four corners of the central citadel. The particulars of these vessels will be 14,650 tons displacement; 19 knots speed; 11-inch belt; 11 to 6½-inch armor on gun positions; main battery, four 12-inch; intermediate battery, eight 8-inch; secondary battery, twelve 6-inch, and twelve 3-inch rapid-fire guns, besides 30 smaller guns.

The five battleships last mentioned are at present on paper the most powerful and best protected ships in the world.

Armored Cruisers.—On March 3, 1899, Congress authorized the construction of three large armored cruisers of 13,000 tons displacement and 22 knots speed, to be named the California, Nebraska and West Virginia. Three more of the same size and speed, which were authorized by the Congress of 1899-1900, are to be called the Maryland, Colorado and South Dakota. The Board on Construction has been so preoccupied with the discussion of the battleship designs that the details of these vessels are not even yet definitely decided, but it is probable that the whole six will be built from the same plans and embody the following features: Displacement, 13,000 tons; speed, 22 knots; protection, a curved deck associated with a continuous belt of 6-inch armor; armament, four 10-inch long-caliber rifles mounted in two turrets fore and aft, and sixteen 6-inch guns mounted within casemates in broadside. These vessels will have an exceptional steaming radius. The last Congress also authorized the construction of three 8000-ton protected cruisers. These vessels will carry, probably (the matter is not definitely settled), four 8-inch rifles in two turrets fore and aft, and either twelve or fourteen 6-inch rapid-fire guns in boadside casemates. In working out the plans of these ships an effort will be made to reserve sufficient displacement for armor to allow a continuous belt to be used at the water-line, thus placing these fine vessels, which are to be of 22 knots speed, in the armored-cruiser class.

Harbor-defense Monitors.—On May 4, 1898, the construction was authorized of the four single-turret monitors, Arkansas, Connecticut, Florida and Wyoming, of 3235 tons displacement, and 11½ knots speed, with 11 inches of armor on sides and barbettes, and armed with two 12-inch rifles and four 4-inch rapid-fire guns.

Semi-protected Cruisers.—On March 3, 1899, a batch of six somewhat nondescript vessels was authorized, which, although they appear in the official list as protected cruisers, are not really so—the protective deck extending only throughout the middle portion of the vessels, the ends of the deck, as in the early Chicago and Atlanta, being unarmored. These vessels, moreover, because of their extremely low speed, are scarcely eligible to be classed in the cruiser classes, where the speed is invariably in new vessels from 21 to 23 knots. The six vessels are known as Chattanooga, Cleveland, Denver, Des Moines, Galveston and Tacoma. They are 3200 tons displacement, 16.5 knots speed, and carry a battery of ten 5-inch rapid-fire guns and a dozen 6-pounders and machine guns.

Torpedo-boat Destroyers, etc.—The same bill of May 4, 1898, mentioned above, included sixteen torpedo-boat destroyers and twelve torpedo-boats, all of which are now either nearing completion or afloat. The destroyers are seagoing craft of 420 to 433 tons displacement and 28 to 30 knots speed; the torpedo-boats are from 157 to 340 tons displacement, and vary in speed from 26 to 30 knots.

Submarine Boats.—The last Congress, impressed by a somewhat favorable report by a board appointed to test the capabilities of the Holland submarine boat, authorized the construction of six vessels of this type, but enlarged and improved.

Of the fleet of vessels outlined above, sixty-one in all, it may be said that as far as the battleships, armored cruisers and torpedo craft are concerned, the designs leave little to be desired. The armored vessels are particularly fine, being large, fast, amply protected, powerfully armed, and possessing great coal capacity; but one regrets that the appropriation voted and being expended on the monitors, submarine boats and semi-protected cruisers (about $11,000,000 altogether) is not being expended on more up-to-date and serviceable vessels. For the same sum we might have secured four first-class battleships, or four armored cruisers of the California type, a squadron of infinitely more value than the abnormal vessels to the construction of which the nation is now committed.—*Scientific American*, July 28, 1900.

THE BATTLESHIP OF THE FUTURE.

A comparative study of the designs of the new battleships which figure in the naval programmes for the year 1900 shows that naval constructors, both in our own and foreign navies, are rapidly tending toward a common type, which, without exaggeration, may be defined as a complete reversal of the ideas of battleship design and construction that have been prevalent during the last ten or fifteen years. In the last of the eighties and in the early nineties of the century, the typical battleship was essentially of what we may call the bulldog type, compared with which the battleship of the opening years of the twentieth century will be a greyhound in speed and activity, while still retaining not a little of the bulldog's fighting power.

The bulldog type, for want of a better expression, is characterized by a hull of bulky model, short and broad; a slow speed of say from 14 to 16 knots; armor of excessive thickness, ranging from 21½ inches in the

French Baudin and the Italian Duilio, and 24 inches in the British Inflexible, to 18 inches in our own Indiana and Oregon; and an offensive battery of a few heavy, unwieldy and slow-firing guns, which weighed as much as 110½ tons apiece in the British Benbow and the Italian Duilio type.

During the past fifteen years there have been three important developments in naval material which have served completely to revolutionize battleship construction. The first of these is the advance that has been made in the methods of armor-plate construction, by which increased resisting power has been obtained with a great reduction in weight. The next is the improvement in the manufacture of guns and explosives, which has been so great as to enable us to secure equal penetration with a gun weighing only half as much as those of the earlier type. The third development has been in the design and materials of boilers and engines, the improvements in which have enabled us to secure a great reduction in engine- and boiler-room weights, and, at the same time, obtain an increase of from 40 to 50 per cent in the speed of the ship.

A mere recital of the leading particulars of the notable battleships of the British navy of the past two decades tells the story of this development. The Inflexible, of the year 1881, was clothed with 24 inches of armor, carried four 16-inch muzzle-loading 80-ton guns, and attained a speed of 12.8 knots with 6500 horse-power. The Camperdown, of 1889, carried 18 inches of armor, mounted four 67-ton guns in her main battery, and attained a speed of 16 to 17 knots with a horse-power of 11,500. The Majestic, designed in 1892, carried 9 inches of armor on her side, was armed with four 12-inch 50-ton guns in her main battery, and attained a speed of over 18 knots with about 13,000 indicated horse-power. The Ocean, completed in the present year, has 6 inches of armor on her belt, carries a main battery of four 50-ton guns, and has attained a speed of 18½ knots with about 14,000 indicated horse-power. In the above statement no mention has been made of the fact that with the decrease in the weight of the main battery there has been a notable increase in the secondary battery of rapid-firing guns, the Ocean carrying twelve 6-inch guns of this type, in addition to eighteen smaller quick-firing guns. In the new battleships of the Duncan class, now building for the same navy, the side armor is only 7 inches in thickness; the battery is the same as that of the Ocean, and the speed has been raised to 19 knots an hour with an indicated horse-power under natural draft of 18,000.

With this last-named vessel it is interesting to compare our latest battleships of the Georgia class, which carry 11 inches of armor on the sides and are armed with four 52-ton guns in the main battery, eight 18-ton guns in the intermediate battery, and twelve 6-inch rapid-firing guns in the secondary battery, while a speed of 19 knots is to be obtained with 19,000 indicated horse-power.

Other ships than those mentioned above show that the tendency to decrease the weight of the main battery is very marked, the two British battleships of the Barfleur type carrying a main battery of 10-inch 30-ton guns, and the latest battleships of the German navy relying upon 9½-inch 27-ton guns for their main armament.

The designs for the new battleships to be laid down this year are of particular interest because they doubtless are intended to embody many of the lessons which were taught by the naval engagements of the Spanish-American war. We have pointed out on various occasions, when discussing the results of the Santiago engagement, that the heavy 12- and 13-inch guns contributed very little to the destruction of the Spanish fleet, the number of hits secured being less in proportion to the number of guns engaged than those credited to any other weapon engaged. Indeed, if one is governed solely by the actual effects produced on the Spanish ships, one is driven to the conclusion that the best armament for a battleship is that which will pour into the enemy a storm of smaller armor-piercing shells, rather than one which will depend upon the great damage wrought by the less frequent but individually more effective shots from the heavier guns.

In view of the fact that the latest battleship designs are provided with armor of from 6 to 9 inches in thickness, and that to secure destructive effects it is sufficient that a shell shall merely penetrate the enemy's armor, it begins to look as though the 12-inch 50-ton slow-firing gun is at once too powerful and too slow for the work which it will be called upon to do. It becomes a question whether the destructive effect of a given number of 12-inch shells would not be exceeded by four times the number of 8-inch shells, any one of which would be capable of penetrating the armor of the latest type of battleship. It is evidently these considerations which have led to the design of the new battleships for the Italian navy, which, on a displacement of 8000 tons, and with armor of a maximum thickness of 6 inches, are to carry no gun heavier than the 8-inch; the main battery consisting of twelve of these very effective weapons carried in pairs in six separate turrets, disposed on the same plan as that adopted in our own battleship Iowa. The secondary battery consists of twelve 3-inch rapid-fire weapons. These 8-inch guns are to be of extremely high velocity, and their rapid-fire mechanism will enable them to fire at the theoretical rate of five shots per minute. Another remarkable feature in these ships is that they are built with very fine lines, and sufficient engine power to drive them 23 knots an hour. Possessing such great speed and maneuvering ability, a vessel of this type could steam swiftly within a range at which the enemy's armor would be penetrable by her 8-inch guns, where she would be able to concentrate no less than eight of these weapons, and pour in a storm of armor-piercing projectiles which might well demoralize the crew and wreck the gun positions of the enemy before his heavy armor-piercing guns could get in a disabling shot. It must be remembered, moreover, that two of these 8000-ton vessels could probably be constructed for but little more than the cost of one of the 15,000-ton battleships of the kind that our own and the British governments are now constructing. It is probable that the predominant type of the next decade will approximate more to the latest Italian battleships than it will to any existing type to-day.—*Scientific American*, June 23, 1900.

CRUISERS AND TORPEDO VESSELS.

In dealing with the subject of cruisers, Commander Ballard rightly commences by pointing out that the question is rendered more intricate than that of the battleships by the greater variety of functions which vessels of the cruiser type are expected to fulfil. For whereas the battleship proper has but one purpose in view, to dispute the command of the sea against all comers, the cruiser, besides in her capacity of scout acting as the eyes and ears of the fleet to which she is attached, is called upon also to serve as the guardian of commerce and to protect lines of communication.

For scouting duties high speed is almost the only essential requisite, and cases may be adduced to show that in the naval maneuvers torpedo gunboats have proved more effective than large cruisers, since by their smaller size and less draught they were able to creep in under the land and escape observation. On the other hand it is a drawback to the employment of such small vessels that a difficulty is experienced in transmitting signals to them, since, by reason of their liveliness, it is difficult to keep a glass fixed on any object for any great length of time.

On the other hand, since, in the matter of initial cost, for the price of one first-class cruiser, ten good torpedo gunboats or five efficient third-class cruisers can be turned out, for scouting purposes it would seem better to employ several of the smaller vessels than one of the larger, since, though one or two of the small craft might be chased and driven off by a hostile cruiser, the rest would have only to disperse in order to slip past her in any direction they pleased.

But for the protection of commerce the cruiser must be able to meet on equal terms any vessel of the cruiser class sent out to destroy her, and the first-class cruiser must therefore be retained.

For the first-class cruiser the essayist adopts classification of the essential requisites similar to that already employed for battleships, except that large caliber gun-power is no longer regarded as necessary, and is therefore omitted, and that, from the difference in the nature of the duties which fall to the battleships and cruisers, the characteristics are rearranged in order of importance.

For cruisers, therefore, the list should stand as follows:

(a) Seaworthiness.
(b) Speed.
(c) Coal stowage.
(d) Medium caliber gun-power.
(e) Protection.
(f) Ram and torpedo-power.

So that speed, which stands fourth in order for battleships, is here placed second, while coal stowage and medium caliber gun-power come before, instead of after, protection.

In order to combine formidable offensive powers with high speed and good protection a tonnage of 13,000 is not considered excessive. This tonnage should command a speed of 24 knots, which is about a knot faster than most of the best foreign cruisers, and the essayist is inclined to favor triple screws, since a ship under easy steam using the central propeller only, with a reverse of steam on the others would probably cruise more economically than with twin screws.

Upon the question of sheathing, a subject which both here and in America has been lately under discussion, it is considered that since our large cruisers have frequently to proceed on long cruises, with infrequent opportunities of docking, it would probably be advantageous that such vessels should be sheathed. For although, when both ships are clean, a coppered ship by reason of her heavier lines is somewhat slower than a similar unsheathed vessel, the advantage is reversed after a very short time out of dock.

A sufficient coal stowage is of course essential to the efficiency of any cruiser, and for a first-class cruiser of 13,000 tons a capacity to carry as much as 2500 tons is regarded as necessary. In connection with the stowage of coal an important remark by Captain Mahan is cited that a too minute subdivision of the bunkers, with a view to reduce her chances of being sunk in action, is very undesirable, since, as in the case of the American vessel Minneapolis, the time spent in coaling and trimming may seriously affect the efficiency of the ship.

Upon the question of the most appropriate armament to be carried by the largest type of cruiser, Commander Ballard is not altogether in accord with the notions which prevail at headquarters at present. The armored cruiser Cressy, now building, of 12,000 tons, is to carry two 9.2-inch and twelve 6-inch guns. He points out that there are two objections to placing guns of large caliber on board of cruisers. The first objection is that the stability is diminished, and the Spanish vessel Reina Regente was so affected in this way that she succumbed to an ordinary gale. And the second drawback is that the frame of a cruiser is not sufficiently strong to withstand the strain caused by the firing of the heavy guns; the American ships Iowa and Texas, regarded as successes when first constructed, having both been seriously injured by the firing of the 12-inch guns. Moreover, guns of 8- or 9-inch caliber are not sufficiently powerful to enable a cruiser to engage a battleship with much prospect of success. These facts, coupled with the consideration that in the matter of weight, two 6-inch guns can be carried for one 8-inch, or three for one 9.2-inch, lead to a recommendation that the armament of the 13,000-ton cruiser should be limited to a battery of eighteen or more 6-inch guns, supplemented by at least a dozen 12-pounder quick-firers. This would reduce the armament of the proposed 13,000-ton vessel to a level not much higher than that of the Monmouth class of 9800 tons now under construction, in which fourteen 6-inch guns and ten 12-pounder quick-firers are to be carried.

In the matter of armor-plates, for cruisers, as for battleships, the essayist lays great stress on the necessity of protecting the guns and the men fighting them rather than the water-line. It is remarked that in the destruction of Cervera's squadron the vessels, although they surrendered to battleships, had their water-lines and machinery practically intact, having been put out of action almost wholly by the fire of the 6-inch or smaller guns. With the proposed armament of 6-inch guns, it is suggested that they should be carried in separate casemates with front plating of 6-inch Harveyized steel, and side and rear plating of about 4 inches.

The necessity of plating the rear as well as the front of a gun is emphasized by the experience of the action at Santiago in which shells were found to explode frequently inside the ships.

The protective deck is also considered an important feature, since it serves the double purpose of protecting the vital portions of the ship from the direct horizontal impact of a projectile, and from the effect of shells constantly exploding above.

A 4-inch belt round the water-line, gradually reduced to 2 inches at the extremities, is also contemplated, as well as a 3-inch shell-proof trunk surrounding the funnel casing between decks. Submerged torpedo-tubes and a ram are considered to be somewhat more applicable to cruisers than to battleships, for possible use as a last resort, since they hardly detract appreciably from the ship's speed, but she should have only light pole masts and no fighting-tops.

It would be well, in the opinion of Commander Ballard, if only money were no object, that all our cruisers should be of the first class. Since, however, the question of expense cannot be altogether disregarded, and since, in the matter of cost, one first-class cruiser is equivalent to two second, and to four or even five third-class cruisers, provision must be made both for ships of each of these types. The ideal second-class cruiser should, he thinks, have a speed of twenty-two knots, and a radius of action of 8000 miles. As armament ten 6-inch quick-firers should suffice, supplemented by 12-pounders, and one-pounder Maxims. For protection she should rely upon her protective deck, and a complete system of isolated shelter for the 6-inch guns, either in the form of casemates or of circular shields five inches thick.

For the third-class cruiser a displacement of 2000 tons would be sufficient, with a speed of twenty-one knots, and she should carry two 6-inch quick-firers, mounted one forward and one aft, and a 12-pounder battery of at least six guns on each broadside. Such vessels to have a radius of action of 2000 miles, and to be unsheathed, since docking facilities are much more general for them than for the larger classes.

From the third-class cruiser of 2000 tons we pass at a bound to the destroyer of some 350 tons. Gunboats and torpedo cruisers of from 300 to 1000 tons displacement do indeed exist in foreign navies, but they are so lightly armed that a single destroyer could meet them on equal terms. For commerce destroyers, too, they are considered too small for distant ocean work and too weak for lines of traffic near home. They are therefore left out of account.

The torpedo-boat proper also may be neglected, as belonging essentially to a defensive system of warfare, and therefore better suited to weaker powers.

The tonnage of a destroyer should be about 350, and her armament two 12-pounders and four one-pounder Maxims on the broadside.

Her coal supply to be such as would carry her for eight or ten days at economical speeds, or two days at full.

As auxiliary vessels, the essayist points out the desirability of attaching a workshop or repairing ship to each fleet, as well as a fast collier or storeship, specially fitted with appliances for rapidly loading or unloading.

Assuming, as is probable, that the winner of the gold medal may be accepted as the exponent of the opinions of his brethren in general, we may note with satisfaction that the fleet is being developed upon lines which meet with the approval of the sea officers. With regard to the few points of detail in which Commander Ballard has any change to suggest, some of his opinions, as we pointed out last week, have received very marked confirmation in the Belleisle experiments. The others, and in particular the important recommendation with regard to reducing the caliber of the principal guns carried by first-class cruisers, may be expected to receive attention from the responsible authorities in due course. —*United Service Gazette.*

U. S. BATTLESHIPS PENNSYLVANIA AND CLASS.

By act of Congress, approved March 3d of last year, provision was made for the construction of three sea-going battleships of great power and speed, equivalent to that of foreign ships of the same type, for the United States navy. After nearly fifteen months' delay, the plans for these new ships have been settled upon. The questions of the price of armor, sheathing and the arrangement of batteries have been responsible mainly for the delay. These are now substantially settled. Krupp armor will be used for the heavy protection; there will be no sheathing, and the much-discussed superimposed turret will not be seen on these ships.

In the arrangement of the main battery, the scheme originally used in the Indiana class will be developed, supplemented by a broadside rapid-fire battery characteristic of all American battleships designed since the battle of the Yalu. The same characteristic light draft is carried out in these heavy vessels, and, to that end, the ships are given plenty of beam and a good deal of length, the latter permitting of lines fine enough to more than assure the maximum required speed. The general features and principal dimensions are: Length on load water-line, 435 feet;. beam, extreme, at load water-line, 76 feet; trial displacement, 14,650 tons; mean draft at trial displacement, 24 feet; greatest draft, full load, about 26 feet; coal carried on trial, 900 tons; coal-bunker capacity, 1900 tons; feed-water carried on trial, 66 tons; maximum indicated horse-power, 19,000; speed, contract, per hour, 19 knots; complement—officers, seamen and marines, 703.

Trial displacement means the vessel and her equipment complete, with 900 tons of coal, 66 tons of water for steaming purposes, plus two-thirds of total ammunition and two-thirds the total stores and provisions, and all the crew.

The ships will have the usual double bottom, and will be divided into the now common close water-tight subdivisions up to the gun deck. All fire mains will be carried below the protective deck, risers leading therefrom up to the stations on the decks above. Woodwork will be limited to the indispensable minimum, and all of that, save the India teak armor backing and the battens for the electric-light wires, will be fireproofed. The decks will be covered with linoleum, with the single exception of the main deck, which will be planked over a complete metal deck. The armor protection to the hull will consist first of an 8-foot water-line belt, which at deepest load draft will be 1 foot above the water-line. This armor belt will extend from bow to stern. Amidships, for a distance of 190 feet, abreast the engines and boilers, it will have its maximum thickness of 11 inches. This 11 inches extends down to a distance of 5 feet, whence the armor tapers to 8 inches at the edge. For a distance of 45 feet forward and aft of this thickest portion the armor will have a maximum thickness of 9 inches, tapering to 6 inches at the lower edge, the next 20 feet forward and aft will be of 6-inch armor, tapering to 4.5 inches, the next 20 feet forward and aft will be of 5-inch armor, reducing to 4 inches at the edge, and the rest of the ships thence to the bow and to the stern will be of armor uniformly of 4 inches from top to bottom.

Above the main belt for a distance of 245 feet—the space occupied by the main, broadside, rapid-fire battery of six 6-inch guns—the sides will be protected by 6 inches of armor reaching all the way up to the main deck on which rest the turrets. This upper and lower casemate armor turns inboard diagonally aft, and butts against the barbette of the 12-inch turret. Forward, this 6-inch armor also turns inboard diagonally and terminates against the forward 12-inch turret, but the lower course, reaching from the protective deck up to the gun deck, is inclined, yielding just that much more protection against a raking fire. There is a complete protective deck, reaching from the bow to the stern. Throughout the run of the main portion of the water-line belt, this deck of 1½ inches rests flatly on the top of the inner upper ledge of this main belt, but thence to the bow and to the stern it curves downward. These slopes are 3 inches thick. A cellulose belt, 3 feet thick, is to be worked along the sides above the protective deck all fore and aft, and reaching up to the under side of the gun deck.

The main battery will consist of four 40-caliber 12-inch breech-loading rifles, and eight 8-inch breech-loading rifles of 45 calibers, housed in pairs in six turrets. The 12-inch turrets are of the elliptical, balanced barbette type. The 12-inch turrets have a general thickness of 10 inches, with port plates of 11 inches. The 8-inch turrets will be balanced, but round, the armor generally for the turrets and barbettes being 6 inches, with port plates of 6½ inches. The faces of all the turrets are sharply cut and inclined, permitting of elevating the guns quite 25 degrees, thereby greatly increasing their bombarding power.

The secondary battery, or main rapid-fire battery, is composed of twelve 50-caliber breech-loading 6-inch rifles of high power. The local protection to these pieces are the 6-inch side armor and the heavy shields to be carried on each gun. Between each pair of these rifles there will be a 2½-inch nickel-steel bulkhead. The arcs of fire of these guns is 110 degrees—55 forward and 55 degrees aft of the beam. The ports or sponsons are set back from the main side line in pairs, so that two of the guns can be turned within the side line of each of the recesses, of which there are three on each side. The 12-inch guns train through arcs of 270 degrees, while the 8-inch guns have arcs of 110 degrees from directly forward and aft back towards the beam.

The ammunition hoists, all of which are electrically controlled, are to have the following rates of supply: One full round of powder and projectile to each of the 12-inch guns every ninety seconds, one full round of powder and projectile to each 8-inch gun every fifty seconds, and three complete rounds to each of the 6-inch guns every minute. The turret turning gear, ramming gear, and elevating gear are all to be under electrical control.

The auxiliary battery will be composed of the following pieces: Twelve 3-inch, 14-pounders, rapid-fire rifles; twelve 3-pounders; four 1-pounders, automatic; four 1-pounders, single-shot; two 3-inch field guns; two Gatlings; six .03-inch caliber automatics. Four of the 14-pounders will be mounted on each side of the gun deck, two forward and two aft of the 6-inch guns; while the four remaining, two on each side, will be mounted on the main deck within the superstructure. All of the 14-pounders, besides their shields, will be protected by broad plates of 2-inch armor. There will be two automatic 1-pounders in each lower top, and two single-shot 1-pounders in each of the upper tops; the other small rapid-fire guns, excepting the field pieces, being mounted wherever advantageous on the forward and after bridges, and on the superstructure deck forward and aft. There will be two submerged torpedo-tubes situated forward, and the firing station, well protected from guns up to the 6-pounder, will be directly above the torpedo-room.

The motive power will be two four-cylinder triple-expansion engines, actuating twin screws, and working in separate water-tight compartments. The cylinders will be: high-pressure, 35-inch; intermediate-pressure, 57-inch, and two low-pressure cylinders of 66 inches, with a common stroke of 48 inches. The engines are expected to make 120 turns a minute when developing the required 19,000 indicated horse-power. Steam at a working pressure of 250 pounds will be supplied by twenty-four straight-tube water-tube boilers, having a heating surface of 56,000 square feet, and a total grate surface of 1290 square feet. There will be six fire-rooms. There will be the usual blowers in each fire-room arranged to provide an ashpit pressure not exceeding 1 inch of water when running under forced draft. The engineer-in-chief has been particularly insistent that the engine-rooms and fire-rooms should be as comfortable as possible, and in the stowage of coal he has seen to it that there are no troublesome pockets.

The electrical generating plant will consist of ten units, each unit to be composed of an engine and dynamo mounted on a combination bed-plate. Two units will have a rated output of 1250 ampères at 80 volts, while the eight other units will have a rated output of 625 ampères each at 80 volts; the total weight of the ten units complete not exceeding 166,000 pounds. Besides lighting the ship inside and out, controlling the turrets and raising the ammunition, the blowers ventilating the hull and turrets will be run electrically; the air compressor for the torpedo flasks will be under electrical control, as will also the machine-shops and the machinery of the laundry. The laundry will be able to handle daily the wash of seventy-five persons.

All principal water-tight doors will be fitted with power devices for closing from a central operating station, and there will be the usual indices showing which of these doors are open or closed. The pilot-house will be of bronze, with a conning-tower of hardened steel, 9 inches thick, underneath it, and there will be a signal-tower 5 inches thick on the superstructure deck just abaft the mainmast. There will be a dense-air plant for refrigerating purposes, having the equivalent of a daily output of three tons of ice. Pipes from this plant will lead to the principal magazines, enabling them to be kept at any desired temperature. The magazines will also be insulated by some approved non-conducting material.

Tanks for fresh water holding quite 10,000 gallons, and an evaporating plant of four units, each equal to a daily output of 4750 gallons, and a distilling apparatus having a per diem capacity of 10,000 gallons will be provided. The accommodation includes separate cabins for an admiral and a commanding officer, a state-room and private bath for the admiral's chief of staff, and forty-two other state-rooms, most of them without the armor protection, so that they can have the advantage of natural ventilation and daylight. The maximum freeboard of 20 feet runs from bow to stern. Thirty-six months is the maximum time allowed for the building of these ships, which will bear the names of Pennsylvania, New Jersey and Georgia.—*The Engineer*, June 8, 1900.

THE CRUISER DENVER.

Work on the construction of the sheathed protected cruiser Denver for the United States navy was begun on June 28 at the shipyard of Neafie & Levy, Philadelphia. This vessel will be the first of six similar cruisers, the others being the Cleveland, the Chattanooga, the Des Moines, the Galveston and the Tacoma, all of which are to be known as the Denver class. They will be 292 feet in length, 44 feet beam, 15 feet 9 inches draft and 3200 tons displacement, with a required speed of 17 knots. The chief peculiarity of the Denver type is that these vessels will be sheathed with yellow pine and coppered. The advantage of this construction is that the vessels will not have to be docked so often as they would of necessity be, if of ordinary steel construction. In salt water steel quickly becomes fouled, and accumulations adhere, whereas those that form on copper peel away, and the vessels can be kept in commission a much longer time without being docked.—*The Iron Age*, July 5, 1900.

H. M. ARMORED CRUISER HOGUE.

Her Majesty's cruiser Hogue, launched by Lady Muncaster on August 13, is a warship of the Cressy type. She is one of the first armored cruisers built since the Australia class was ordered over 10 years ago, and constitutes an entirely new type of fighting ship. In many respects the Hogue resembles the Powerful, also built by Messrs. Vickers, Sons and Maxim, Limited, embodying the best features of that magnificent ship, with the addition of an armored belt of considerable area. The displacement is 12,000 tons. The hull is sheathed with teak and coppered. The armament comprises 9.2-inch (22-ton) guns, each mounted in armored barbettes, the mountings being a special design of the Vickers Company, by which the guns can be loaded at any angle of elevation for training. These 9.2-inch guns fire a 380-pound projectile with a muzzle energy of 14,520 foot-tons. There are also eight 6-inch guns, with a great range of fire, and there are distributed throughout the ship twelve 12-pounder quick-firing guns and a number of machine guns. The four boiler compartments of the Hogue take up 130 feet of the length of the ship, the coal-bunkers being arranged on either side of the boiler-rooms, and over the protective deck; and an ammunition passage is situated immediately under the protective deck. There is also an athwartship bunker right forward. Thirty boilers are carried, all of the Belleville type. The boilers have been designed with the most liberal steam-generating surfaces, so that no difficulty should be experienced in obtaining the full power, and even more, if of any utility; and at the same time a higher power is obtained per ton of machinery than could be realized with ordinary boilers. At full power the engines will make 120 revolutions, which is estimated to drive the ship at 21 knots. The gun mountings, under manufacture by Messrs. Vickers, will be placed on board previous to the official trials being carried out, and when ready to leave Barrow, the Hogue will be delivered to Her Majesty's dockyard, Devonport.—*Engineering*, Aug. 17, 1900.

H. M. TORPEDO-BOAT DESTROYER VIPER.

Last week the new torpedo-boat destroyer Viper, which has been built by Hawthorn, Leslie & Co., Hebburn, to the order of the Parsons Steam Turbine Company, underwent a series of steam trials, and, in accordance with anticipations, eclipsed all previous records for speed. The vessel is 210 feet long, 21 feet beam, has a depth of 12 feet 6 inches, and is propelled by steam turbines fitted by the contractors. The engines are similar to those of the Turbinia, but are in duplicate, and consist of two distinct sets on each side of the vessel. There are four screw shafts in all, entirely independent of each other, the two on each side being driven by one high- and one low-pressure turbine respectively, of about equal power; while the two low-pressure turbines drive the two inner shafts, and to each a small reversing turbine is also permanently coupled, and revolves idly with them when going ahead. Two propellers are placed on each shaft, the foremost in each case having a slightly lesser pitch than the after one. The thrust from the screw shafts is entirely balanced by the steam acting on the turbines. So far as the boilers, auxiliary machinery and condensers are concerned, they are of the usual type in such vessels; but their size is increased to meet the much larger power to be developed, and to compensate for the lesser weight of the main engines, shafting and propellers, as well as the lighter structure of the engine beds. The boilers are of the modified Yarrow pattern, with a total heating surface of 150,000 square feet, and grate surface of 272 square feet; while the condensers have a cooling surface of 8000 square feet. Steam is admitted directly through a regulating valve to the high-pressure turbine driving one shaft, after which it passes to the adjacent low-pressure turbine, driving its shaft independently, thence it flows to the condenser, and both the shafts then drive the vessel ahead. The reversing turbine revolves with the low-pressure shaft, and being permanently connected with the vacuum in the condenser, no appreciable resistance is offered to its motion under these conditions. To go astern the ahead steam valve is closed, and the astern steam valve opened, admitting the steam from the boilers to the reversing turbine, and reversing the direction of rotation of the inner screw shaft. On the other side of the vessel the arrangement is the same, so that she can be maneuvered as an ordinary twin-screw vessel, and with great facility and quickness. In ordinary reciprocating engines the weight of machinery for each indicated horse-power developed is 55 pounds, while in the turbine the weight of machinery per indicated horse-power is said to be only 35 pounds, thereby effecting a great saving in weight. The engines are all below the water-line—an essential factor in the construction of war vessels. Owing to a dispute amongst the engineering staff employed on board the Viper, says the *Newcastle Chronicle*, the trial of the boat had to be carried out last Friday by apprentices and the office staff, but the success of the trip was not impaired, as will be seen from the following particulars, for which we are indebted to the paper above mentioned: The Viper left the works shortly after 11 o'clock, steaming to the harbor mouth at 15 knots, and twenty minutes after passing the North Pier end she increased her speed to 36.585 knots. Subsequent spins showed a speed of 35.503 knots, 37.113 knots, 36.585 knots, 37.113 knots, and the last 36.072 knots, the Admiralty mean speed for the six runs showing 36.581 knots. In the trials the turbines made 1180 revolutions per minute, and developed 12,000 indicated horse-power.—*The Engineer*, July 20, 1900.

THE JAPANESE ARMORED CRUISER ADSUMA.

The Adsuma, built at St. Nazaire, save in the matter of dimensions and one or two small details, is a sister to the Yakumo, a ship that has already been described at length in *The Engineer*. Like the Yakumo, she is the original Japanese design for the Asama class, and slightly inferior to those vessels in armament and disposition of guns.

Her details, as compared with those of the Yakumo and Asama, are as follows:

Order of age	3	2	1
Name	Adsuma	Yakumo	Asama
Built at	St. Nazaire	Stettin	Elswick
Displacement, tons	9,436	9,850	9,750
Length over all, feet	446	407	408
Beam	59	65⅝	67
Draft, mean	24¼	23¾	24¼
Horse-power	17,000	16,000	19,000
Maximum speed, knots	21	20	22
Boilers	Belleville	Belleville	Cylindrical
Screws	2	2	2
Coal, normal, tons	?	550	550
Coal, maximum, tons	?	1,300	1,300
Material of armor	Krupp	Krupp	H. Nickel
Guns, *8-in	4	4	4
6-in	12	12	14
3-in	12	12	12
smaller	12	12	7
Torpedo tubes, submerged	4	4	4
" " above water	0	1	1
Armor belt, amidships, inches	7	same for all.	
" " ends, inches	3½		
" deck, inches	2½		
Casemates and turrets, inches	6		
Lower deck side, inches	5		

* All guns and torpedo tubes are Elswick make.

The assumption is that the Adsuma's coal supply is about the same as that of the other ships, but doubt exists on this point. It should be noted that the Asama and Tokiwa were built first—their, sisters, Idzumo and Iwate, now building at Elswick, have Krupp armor, and lack the bow torpedo-tube which the Japanese have now discarded.

It is interesting to compare the dimensions of these various craft, and to note how long and narrow the French vessel is in comparison with the Elswick model, which is, relatively to beam, the shortest of the class, although the swiftest. This would imply that the Adsuma in a heavy sea would be less likely to lose her speed, but in no weather is she likely to be as handy, or anything like as handy, as the Asama type, which is probably a much better sea boat also.

The Adsuma was originally intended to have two funnels only, but she has been built with three, the peculiar placing of which makes her not very unlike the French cruiser d'Entrecasteaux in appearance. Her funnels are noticeably short and stumpy.

A noteworthy item in connection with these ships is their speed. All, we believe, cost about the same price; the higher speed and superior armament of the Elswick vessels would seem, therefore, to indicate that the British firm is able to give more for the money than the foreigners, despite the legend that the Continent is the place for cheap work.

Harvey-nickel armor is, of course, cheaper than Krupp, costing only some £80 or so per ton against £110 per ton for Krupp cemented. The Elswick cruisers Idzumo and Iwate have, however, Krupp armor, which is paid for by the reduction of a knot in the speed. This still leaves them 21-knot ships, and, of course, they still carry the two extra 6-inch quick-firers.

Armored cruisers is the designation given to all these vessels, though from our point of view it is nominal only, since the Japanese do not propose to use them as cruisers so much as second-rate battleships. Five Asamas can be constructed for the price of three Hatsuses, and it is a pretty problem which is the best value for the money. Against modern vessels, three big first-class battleships would no doubt be better than five smaller craft devoid of heavy armor-piercing guns; but comparatively few of the world's warships are quite modern. Against older types the five medium vessels may well be held better than the three very powerful ships. All this, however, is speculation, concerning which there will be no definite answer till two first-class powers are involved in a naval war.—*The Engineer*, Aug. 17, 1900.

TORPEDO-BOATS FOR THE DUTCH NAVY.

The vessels are named Hydra and Scylla, and are intended to strengthen the naval power of the Dutch authorities at their East Indian colonies. They are 130 feet long and 13 feet 6 inches beam, and have a displacement of about 90 tons. Their guaranteed speed on official trial, carrying a load of 16½ tons, for three hours, was 23 knots.

The general arrangement of these boats is similar to what is customary in vessels of this class, the crew space being forward and the officers and petty officers having their cabins aft. The machinery consists of a set of inverted triple-expansion surface-condensing engines, indicating about 1200 horse-power. The air and feed pumps are driven off the forward end of the crankshaft.

The special feature about these engines, in which they differ from those of other torpedo-boats, is the system of forced lubrication which has been adopted, the working parts of the engines being completely enclosed. This plan has been introduced with great success in many types of land engines, such as those manufactured by Messrs. Belliss and Morcom. The great advantage of forced lubrication is that all anxiety on the part of the engineering staff is set at rest as regards this point, which is one of the most important in the proper working of such fast-running machinery. As a consequence, a small engine-room staff may, in case of emergency, control the machinery; as the lubrication, being self-acting, does not require attention. This might be a circumstance of the very first importance in time of war, when engineers and artificers may be very scarce indeed.

There is a centrifugal circulating pump with its engine, for supplying the condenser with water; an evaporator and distilling plant, in duplicate; steam steering engine and air compressor; also dynamo for electric lighting. There is an overhead fan and fan engine in the stokehold between the two boilers, for forced draft.

The boilers are of the Yarrow water-tube type, with, of course, straight tubes. We learn that this type of boiler is rapidly gaining in favor abroad, and has now been installed in a very large number of cruisers and ironclads with considerable success.

There is a Worthington pumping engine in the stokehold for feeding the boilers when the main engines are not working. The bunkers hold about 18 tons of coal. The armament consists of three 18-inch swivel torpedo-tubes, and two 6-pounder quick-firing guns.

The official trial of the Hydra took place on May 25, under the direction of Mr. Loder, Chief Constructor of the Royal Dutch Navy, Mr. Koning, Engineer-in-Chief, and Captain de Booy, who will command the vessel. A mean speed of 24.37 knots was made for the three hours, with 160 pounds of steam, and a trifle over 400 revolutions per minute, the load carried being 17½ tons.

The official trial of the Scylla took place on June 26, with practically the same results. This trial was directed by Mr. Loder and Mr. Koning, who again represented the Dutch authorities, assisted by Captain Smit, who will command this vessel.

Both these vessels have since had a full-speed trial to show their capabilities when burning astatki, by means of Holden's spraying apparatus, with which the vessels are fitted. It has been shown by these trials that there is no difficulty in burning this oil, and as it is plentiful in the Dutch East Indies, there is no doubt it will be found an important adjunct to coal. It is proposed to burn the two in combination, as usual on the Great Eastern Railway.

The Hydra and the Scylla will be immediately fitted with their equipment in Holland, and it is expected during next month they will start for their station in the east via the Red Sea.—*Engineering*, July 20, 1900.

NORWEGIAN ARMOR-CLAD EIDSVOLD.

The Eidsvold, a coast-defense ship of 3850 tons displacement, was launched from Elswick shipyard yesterday. She is a sister ship of the Norge, built by the same firm, and with her forms the most powerful units of the Norwegian navy. She is 290 feet long, 50 feet broad, and has a draft of 16 feet 6 inches. She will carry two 8.2-inch guns, in shielded barbettes of 6-inch nickel-steel; six 6-inch guns, four in casemates of 5-inch nickel-steel at the corners of the battery, and one on each broadside in the center protected by shields; eight 12-pounders, six 3-pounders, and two submerged torpedo-tubes. She has an armored belt of 6-inch Harveyed steel extending between the barbettes, and a 2-inch armored deck, all fore and aft. Two sets of vertical triple-expansion engines, developing 4500 indicated horse-power are to propel her at a maximum speed of 16½ knots. Steam will be supplied by Yarrow boilers.—*The Engineer*, June 15, 1900.

HIGH SPEED IN WAR VESSELS—THE VARIAG AND THE VIPER.

The details of the successful trial of the protected cruiser Variag, which has been built at the Cramps' Yard, Philadelphia, Pa., for the Russian navy, show that this vessel is well able to live up to her contract requirements of 23 knots an hour. The contract specified that the speed trial should be an extraordinarily severe one. The vessel was to maintain a sea speed of 23 knots an hour for a run of twelve consecutive hours. During a preliminary builders' trial she is said to have logged for a time the remarkable speed of 24.6 knots an hour, covering ten miles at 24.2 knots. This, of course, will not be quoted as the official speed of the vessel, as trials by log are not regarded as fully reliable; but on the official trial, where the times are taken over a measured course, there is no possibility of error, and the fact that this vessel maintained for over seven hours a continuous speed of from 23.6 to 23.7 knots an hour was considered by the Russian officials to be sufficient evidence that she could have maintained the same speed for the whole twelve hours, had it not been for an accident to one of the high-pressure cylinders.

This splendid result is extremely gratifying both to the representatives of the Russian navy and to the American builders of the ship. The William Cramp & Sons Ship and Engine Building Company had already achieved world-wide distinction in the construction of fast warships by the remarkably high speeds which were attained by the Minneapolis and Columbia, vessels of somewhat the same character as the Variag, and about 1000 tons more displacement. The Columbia is credited with a speed of 22.8 knots an hour, and the Minneapolis with slightly over 23 knots. The Variag, with her record of 23.7 knots, now takes the place of the Minneapolis as the fastest first-class cruiser in the world, although she is exceeded in speed by two second-class cruisers, which, strangely enough, are to be found in the Chinese navy. The Hai-Tien, a second-class cruiser of 4300 tons displacement and 17,000 horse-power, achieved a speed on her official trial of 24.1 knots an hour. A sister ship of the Hai-Tien, the Hai-Chi, made 24 knots on her official trial. These two vessels, however, are smaller than the Variag by 2200 tons, and it is doubtful if in any but the finest weather they could hold their own with the American-built ship.

The Variag, is one of the four protected cruisers which are being built for Russia in various foreign shipyards. Two of these, the Bogatyr and the Boyarin, must be about completed at Stettin and Copenhagen, and a fourth, the Askold, at the Germania yards at Kiel. All four vessels are required to steam at 23 knots for twelve hours; and while the ships conform to a general pattern in respect of armament, coal endurance and speed, the builders have been given a free hand in matters of detail. When the quartette is completed, it will be interesting to compare the work of American builders with that of the European yards mentioned.

At the close of the trial the officers and naval experts commissioned by the Russian government to superintend the trial of the Variag congratulated the builders on her performance and stated that they considered the cruiser to be one of the great triumphs of naval construction. An illustrated description of the Variag was given in the *Scientific American* for November 5, 1898; and the Askold is illustrated in the issue of June 30, 1900.

Further details at hand of the wonderful speed recently made by the torpedo-boats Cobra and Viper show that the introduction of turbo-propulsion has opened up possibilities in speed, the limits of which it is difficult to predict. It is only five years since the torpedo-boat destroyer Sokol, built at Poplar, for the Russian government, astonished the world by making a speed of 30 knots an hour; yet to-day 30-knot destroyers have ceased to excite interest; and the success of the Viper in covering a measured mile at the rate of 37.1 knots an hour is already leading us to regard 40 knots an hour as the next goal at which to aim.

The Viper is 210 feet long, 21 feet wide, and has a draft of 7 feet. On the recent trial she displaced 380 tons, or 10 tons more than the contract requirement. Six runs were made over the measured mile at the following speeds in knots: 36.6; 35.5; 37.1; 36.6; 37.1; 36.1, the mean speed being 36.58 knots per hour. The highest speed attained is equal to about 43 land miles per hour. The turbines indicated 12,000 horse-power at 1180 revolutions per minute, under a steam pressure of 200 pounds to the square inch.

The remarkable success of turbo-propulsion naturally invites speculation as to the possibilities of the future, not merely in torpedo-boats, but in the larger field of the cruiser and battleship. Then, again, there is the question of its application to the merchant marine, where the record for speed now stands at 23 knots an hour. There is no doubt that the turbine could be applied successfully to a 25,000-ton liner, and that speeds of 30 knots and over could be realized; but it would be at a cost for fuel that would be absolutely prohibitive. Indeed, Mr. Parsons, the inventor of the turbine, has stated that he could put turbines and boilers in a transatlantic liner that would drive her across the ocean in three days, if the owners of the vessel would be willing to burn the 10,000 to 12,000 tons of coal that would be consumed in the furnaces.

Although the Parsons turbine, in proportion to its indicated horse-power, is remarkably light and compact, it has a voracious appetite for steam; so much so, that Admiral Melville once said that what surprised him in the Turbinia was not so much the indicated horse-power of the turbines as the enormous quantities of steam supplied by the boilers. So that, if we are anxious for a three-day crossing of the Atlantic, we must make up our minds to pay for an enormously expensive luxury; so costly, indeed, that the three-day boat, using coal as its fuel and steam in its motor, will probably never pass from the theoretical to the practical stage.—*Scientific American*, Aug. 11, 1900.

TWO NOTABLE HIGH-SPEED FOREIGN CRUISERS.

It is now many years since our famous high-speed cruisers, Minneapolis and Columbia, startled the naval world by the then unprecedented speed which they achieved on their trial runs. The Columbia, it will be remembered, maintained on her trial an average speed of 22.8 knots an hour, while the Minneapolis was officially credited with an average of 23.07 knots an hour. Nothing of the kind had hitherto been accomplished by vessels of the size and sea-going ability of these ships, and it is a fact that to accomplish these results considerable sacrifices were made in their offensive and defensive qualities. The armament was light, and the protection was confined to an armored deck. Contemporary vessels of the Minneapolis and Columbia that carried heavy armament and were protected with a belt at the water-line, such, for instance, as the New York and Brooklyn, only secured these advantages by a sacrifice of speed.

Improvements in the materials of construction, the introduction of tubular boilers, and the construction of engines suited to a high speed of revolution, have enabled designers to provide heavily armored vessels with a speed which was altogether impossible at the time the Minneapolis and Brooklyn were built, with the result that it is getting to be quite the fashion to provide even the armored cruisers with sufficient power to drive them at speeds of from 22 to 24 knots an hour.

Two of the latest of the high-speed cruisers that have been built in European yards are required by contract to achieve a speed of 23 knots an hour. One of them, the Chateaurenault, has had her trials, and has easily exceeded 23 knots an hour, the speed on certain stretches of the trial course reaching within a fraction of 25 knots per hour.

I. Askold.—The Askold is one of the four protected cruisers which are being built for the Russian navy in foreign shipyards. One of these, the Waryag, has been constructed at the Cramp shipyard, Philadelphia, and is now undergoing her trials. Two others, the Bogatyr, and the Boyarin, have been built respectively at Stettin and Copenhagen, while the Askold is nearing completion at the Germania yard, Kiel. All four vessels are to have a speed of 23 knots an hour, and carry the same armament, although there will be a difference in the matter of its disposition. The Askold has a displacement of 6000 tons on a draft of 20 feet 4 inches. She is 426 feet 6 inches in length, 49 feet 3 inches in beam, her normal coal supply is 710 tons, while her bunker capacity is 1000 tons.

It will be noticed that the ratio of beam to length in the Askold is about 1 to 9; a most exceptional proportion for a warship, and one that is only found in fast steamers of the merchant marine, and in small fighting craft of the torpedo-boat and destroyer type. In this respect the Askold differs materially from the other three vessels of her class, the Waryag, for instance, having a beam of 52 feet and a length of 420 feet, or about 1 to 8. In consequence of her finer lines the Askold is 500 tons less in displacement than her sister ships, the Waryag displacing 6500 tons and the Askold 6000 tons.

Her armament is identical with that of the Waryag, although it is somewhat differently disposed. It consists of twelve 5.9-inch guns, of which six will be mounted in sponsons, three on each broadside on the main deck, while four will be mounted in recessed ports on the same deck, two forward and two aft. Of the other two guns, one will be mounted on the quarter deck and one will be mounted on the superstructure deck, above the forecastle, and well toward the bow. All of the above guns will be of the rapid-fire type. The Askold will also carry a dozen 3-inch rapid-fire guns, four forward, four aft, and four amidships on the gun deck; eight 3-pounders, two 1-pounders and two automatic machine guns. She will also be provided with six torpedo-tubes, two of which will be submerged. The protective deck will be 3 inches in thickness, and the principal gun positions will be protected by 5-inch to 3-inch nickel-steel.

It must be confessed that the Askold has a very striking appearance, and is suggestive of an overgrown torpedo-boat destroyer more than of a first-class cruiser. This is due in part to her possession of no less than five tall smokestacks, a number which has never before been placed on a warship. Her boilers will be of the water-tube type, and will supply steam to three sets of triple-expansion engines, driving three propellers, a system which was adopted with success in our own Minneapolis and Columbia. The complement of the Askold is to be 580 officers and men. If our readers wish to make further comparison of this fine vessel with the sister ship recently built by the Cramps, they are referred to the *Scientific American* of November 5, 1898, in which will be found an illustrated description of the Waryag.

II. Chateaurenault.—The French protected cruiser, the Chateaurenault, was laid down at La Seyne in 1896 and launched in 1898. She is 443 feet long between perpendiculars, has a beam of 55 feet 9 inches, and a mean draft of 22 feet 6 inches, with a displacement of 8018 tons. She is thus about 600 tons larger than the Minneapolis. Like her, she is driven by three sets of vertical, triple-expansion engines. The boiler plant consists of fourteen Norman-Sigaudy double-ended boilers, which supply steam at a working pressure of 210 pounds to the square inch. It will be seen that she has unusual smokestack capacity, for not only are there four smokestacks, but they are of large diameter. Hence, the Chateaurenault should have no difficulty in realizing a natural-draft horse-power of 13,800. The contract horse-power under forced draft is 23,000, and the corresponding speed is 23 knots.

The armament consists of two 6.5-inch rapid-fire guns mounted on the main deck, one forward, one aft, and protected by shields, each gun having a separate ammunition hoist; six 5.5-inch rapid-fire guns in sponsons on the gun deck, two firing dead-ahead and two dead-astern, and each protected by a circular shield; and ten 3-pounders and five 1-pounder rapid-fire guns mounted in commanding positions throughout the ship. For protection the vessel depends upon a steel deck which is 2¾ inches thick on the flat and 4 inches thick on the slopes above the machinery. There is also 2¾ inches of steel protection on the sponsons for the guns.

The Chateaurenault is designed for the same class of work as our Minneapolis and Columbia, that of commerce destroying, and in order to prevent detection when she is searching for the merchant ships of the enemy, she has been made to conform, as far as possible, to the outward appearance of a modern transatlantic steamer. Hence, there are no fighting tops on the vessel, and her masts and funnels are given the rake and trim appearance which characterize the pole masts of a merchant steamer.—*Scientific American*, June 30, 1900.

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NAVAL INSTITUTE PRIZE ESSAY, 1900.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1901. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute. If the essayist second in order of merit receive "Honorable Mention," he will also be made a life member.

The prize essay for 1899 was won by Lieut. R. H. Jackson, U. S. N., the title of the prize essay being "Torpedo Craft: their Type and Employment." Lieut. L. H. Chandler, U. S. N., received Honorable Mention for an article entitled "The Automobile Torpedo and its Uses." and was made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of the Board of Control.

E. W. EBERLE,
Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *June 1, 1900.*

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ERRORS OF GUN-FIRE AT SEA.

By PROFESSOR PHILIP R. ALGER, U. S. N.

That the gun will always be the decisive weapon in naval combat seems to me the most natural conclusion to be derived from theoretical considerations, and such practical experiences as recent wars have furnished would tend to the same conclusion. Gun-fire and gun-fire alone decided every naval action which took place in the war between China and Japan and in our own war with Spain, and whatever other conclusion may be drawn from those wars, they should certainly have taught us the overwhelming advantage given by a superior volume of effective gun-fire. How to make the volume of effective gun-fire of any given ship a maximum should, then, be considered the most important end which her officers can possibly have in view, and, since marksmanship is the prime factor in effective gun-fire, a study of the errors of gun-fire at sea and the methods of minimizing them should be of great value. Those who are without practical experience naturally fail to appreciate the difficulty of hitting a target with a gun on board ship, but even naval officers, I think, usually underestimate the errors of gun-fire at sea, and especially so at the great ranges which are likely to be used in naval actions. The ever increasing effectiveness of offensive weapons, with which the development of the defense in itself never keeps pace, is well known. That the rapidity of fire, as well as the muzzle velocity with its accompanying flatness of trajectory, of modern guns, whether shoulder rifles or heavy ordnance, are much greater to-day than they ever were before, is a matter of common knowledge, and the natural consequence which would seem to follow is a greatly increased destructive effect. That the real result has been the opposite of this, at least in land fighting; that increased efficiency of offensive weapons has continually resulted in less loss of life in battle, few have observed. Yet this is true, and the reason is not far to seek. It is because, all other defenses having proved inadequate, the defense of distance has been more and more made use of. In the days when it could be truly said that beyond 150 yards no man was in danger from a shot which was aimed at him, it was necessary to any conclusion that battles should be fought almost, if not quite, hand to hand. To-day, when, if the distance be known, a good target can be made with the small arm at 1800 yards and when, up to 700 yards, the shooting is point blank, a great battle may be decided without there being a single opportunity for either side to fire an aimed shot at an individual opponent. In like manner, upon the sea, there has been a constant tendency to seek the defense of greater and greater distances in proportion as the offensive power of naval ordnance has increased. The surprising reports of "no casualties," when Dewey's ships withdrew for a time from the action at Manila Bay, may be in part attributed to the complete inefficiency of the Spanish navy, and its shameful neglect of gun practice, but it must not be forgotten that the action opened at nearly 6000 yards, and that the Spanish had for a target moving vessels which were never nearer than 2000 yards, and whose mean distance, during the first and really decisive engagement, must have been nearly two miles. Our much greater volume of fire, and the comparative immobility of the Spanish ships, resulted in an easy victory, but the percentage of hits from our own guns, though greater than the enemy's, was nevertheless very small. I have been told by an officer of the Raleigh that, during one phase of the action, he distinctly saw that the shots from the Baltimore and Olympia were falling at least 500 yards short of the enemy.

I take a range of 2000 yards as a basis for a discussion of the errors of gun-fire, but the principle of the " rigidity of the trajectory " indicates that most of the errors are proportional to the range, and that the total errors at 3000 yards, for example, will be about fifty per cent greater than at 2000 yards range.

If the points of impact of a great number of shot are plotted on a vertical target at whose center the gun is pointed, what is called the " mean vertical error " is the arithmetical mean of the distances, either above or below the center of the target, of all the points of impact; and the " mean lateral error " is similarly the mean of the sidewise errors.

The " probable error " or the error such that half the shot have a less, and half a greater error, is a little less than the mean error just defined, so that while 50 per cent of all the shot fired would be found within a band double the width of the " probable error," 57½ per cent would be found within a band twice as wide as the " mean error."

" Tables of probability," found in many books on ordnance, give the percentage of hits for bands of given width in terms of the mean error, and by knowing both the mean vertical and the mean lateral error of a gun, we easily find the percentage of hits within any given lateral limits, the percentage within any given vertical limits, and then, by multiplying these percentages together, the percentage of hits on any given rectangular area. The first step, then, in determining the probable percentage of hits with any given gun is to determine the mean vertical and lateral errors of the latter, and this I shall now try to do in a rough, but I think sufficiently accurate manner, by considering the separate causes of error, and the effect of each separately, and then combining them; and furthermore, I shall make no attempt to discriminate between the different calibers, but shall assume all so-called " main battery " guns to have practically the same mean error, which, while not exactly true, is still, for the purposes of my general review of the subject, sufficiently accurate.

Now the mean error of the gun itself does not exceed 2 feet laterally and 5 feet vertically at 2000 yards, that is, if the range be known, the line of sight be truly on when the projectile leaves the muzzle, and there be no wind, the impact will, on the average, be within 2 feet laterally and 5 feet vertically of the center, the excess of vertical over lateral mean errors being due to variations in muzzle velocity from round to round. The great precision of the modern heavy gun may be judged from the target record which I have here of a 10-inch army gun at 2000 yards range, which shows mean errors, both vertical and horizontal, of less than 1 foot. The high velocities, with accompanying great variations in velocity, given by smokeless powder, have probably tended to increase the mean error of the gun somewhat, but my assumed figures of 2 feet lateral and 5 feet vertical mean error at 2000 yards are certainly not an underestimate.

Taking next the errors due to rolling and pitching, and assuming that electric firing is used so as to reduce to a minimum the firing interval, I estimate the vertical and lateral mean errors at 2000 yards range from this cause to be each about 3 feet, the first of these errors being due to angular movement between the moment of firing and the departure of the projectile from the muzzle, and the second being due to inclination of the axis of the trunnions at the moment of firing. Next considering error due to wind: this is practically lateral only, and supposing it due to a 10-knot breeze at right angles to the line of fire, would be about 3 feet. The error caused by the relative movements of gun and target is also practically only lateral, and, if due to a mistake of 4 knots in the lateral motion allowed for in sighting, would be about 20 feet at 2000 yards. Finally, we have to consider the fact that the range is only approximately known, and that, consequently, there is always an error in setting the sights. Supposing this to average 100 yards, and the result is a mean vertical error at the target of about 7 feet with our present service guns, and, of course, it will be less when muzzle velocities are increased. Now taking the square root of the sum of the squares of all the foregoing errors, we have for the total mean lateral error 20½ feet, and for the total mean vertical error 9 feet.

Let us see how nearly the results of firing agree with these figures. It was the actual count of the hits on the Spanish ships at Santiago which first gave us a measure of our own efficiency as marksmen. The rapid and complete destruction of the Spanish squadron seemed to justify the enthusiastic praises then being showered upon our "Yankee gunners." But when the hits came to be actually counted, the astonishing result was that of some 9500 projectiles fired, only 123, or 1.3 per cent, had found their mark on the Spanish ships. Considering the guns as divided into three classes, I find that, from the heavy guns, 8-inch, 12-inch and 13-inch, 405 shots were fired with 16 hits, or nearly 4 per cent; from the medium guns, 4-inch, 5-inch and 6-inch, 895 shots were fired with 30 hits, or 3.4 per cent; while from the 6-pounder guns, 6580 shots were fired with 77 hits, or 1.2 per cent. I omit consideration of nearly 1600 shots fired from smaller guns, and count all their hits as 6-pounders, as it is impossible to certainly distinguish a one or a three-pounder hit from a six-pounder. Furthermore, assuming that all the 8-inch, 12-inch and 13-inch shell and most of the 4-inch, 5-inch and 6-inch were fired at the Spanish ships, while many of the minor caliber shots were fired at the torpedo-boats, and also allowing for the fact that there were probably some hits on the Spanish ships which escaped observation, I conclude that, while the percentage of hits was somewhat less for the minor caliber guns than for the larger guns, for all calibers of the latter, from 4-inch to 13-inch, it was practically the same, and in the neighborhood of 4 per cent, certainly not as great as 5 per cent, and probably very slightly greater than 4 per cent. Let us see what we must conclude from these percentages of hits as regards the errors of the guns. A consideration of the positions of the ships as laid down by the board of navigators indicates a mean range, during the decisive part of the action, of about 2800 yards. To get this, I take the average of the distances of each of our ships from her nearest opponent during that part of the action in which such distances were not too great for a reasonable chance of hitting, and then, by assigning a greater weight to the nearer distances than the farther ones, I make a new average, which I consider the mean range for the entire battle.

Next I assume as the mean size of target offered by each Spanish ship, a rectangle 200 feet long and 24 feet high, which, considering their position relatively to our line of fire, cannot be far out.

Finally, with the foregoing data and on the assumption that the mean lateral and vertical errors were equal, it is easy to pick out from any table of probabilities the mean error of our guns as having been about 100 feet. It is astonishing, but nevertheless I think it is beyond doubt, that at a range of 2800 yards the mean error of the guns at Santiago, if measured on a vertical target, would have been found to be about 100 feet, that is, nearly half our shot went more than 100 feet to one side or the other of the center of the ship aimed at, and nearly half went more than 100 feet above or below the same point.

But my theoretical mean errors of 9 and 20½ feet respectively at 2000 yards are only about one-fifth of those just found to have actually been made at Santiago—the percentage of hits, according to my figures of the guns' accuracy, should have been 57 instead of 4. In what, then, lies the explanation of this discrepancy, and why, if my figures in regard to the accuracy of the gun are anywhere near correct, do we not almost always hit the target? The answer is very simple. Thus far I have assumed that the line of sight is on the center of the target when the gun is fired. Actually this is never the case, and upon how great this "error of pointing" is, really depends almost entirely the accuracy of gun-fire. To account for the results at Santiago, we have to suppose that the mean error of pointing our guns was nearly a degree. What then causes this greatest of all the errors of naval gun-fire. It has two causes: one depending on the individual gun-pointer and only to be reduced by skilful allowance on his part; the other mechanical and capable of almost entire elimination.

The first cause is what is known as the "personal error" of the gun-pointer—the time between his willing to fire the gun and his actually firing it. If he wills to press the button when the line of sight is on the target, the motion of the ship has displaced the gun before he can really do so. With electric firing only about 1-50 of a second elapses between the actual pressing of the firing key of a 12-inch gun and the departure of the shell from the muzzle, and I have already made an allowance of 3 feet vertical error for the ship's roll during this interval. But it takes about 3-10* of a second for a man to translate the desire to fire into the actual motion of his hand, and the vertical error due to roll during this " willing interval " may be very great. Of course this error disappears if the sea is perfectly smooth, or if the gun is fixed at the end of a roll, but the first case is rare, and the second can only be approximated to. It is certainly important to reduce this error by pointing so that the line of sight comes on near the end of the roll, but as a rule the gun-pointer will have to make up his mind to fire just before the line of sight comes on in order to have it really on when the gun goes off, and I fear that the mean vertical error, at 2000 yards range, due to this part of the error of pointing, cannot be less than about 21 feet. This is on the assumption that on the average the gun-pointers can correct the error to within one-third of its uncorrected value, and that the ship has an average rate of roll of 2° a second during the 1-10 of a second which is not allowed for.

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* This estimate is based upon tests made at the Torpedo Station by Lieut. Comdr. F. F. Fletcher. It is very large as compared with what is called the "personal equation" as determined for astronomical observers, but that is because the latter almost invariably, either voluntarily or involuntarily, attempt to correct their own errors, as is shown by the fact that some observers have negative personal equations. If a man be told to press a key when a signal is made, and if the nature of the signal is such that he has no means of ascertaining or estimating when it will come, then, according to Mr. Fletcher's experiments, an average period of 3/10 of a second will elapse between the giving of the signal and the actual pressing of the key.

The second cause of the error of pointing is the inability of the human eye to see distinctly at the same moment objects at greatly different distances. When the gun-pointer attempts to bring into line the rear sight, the front sight, and the target, he glances along the line of sight from one to the other, but if he sees one of these three objects distinctly, the others are necessarily blurred. Consequently he cannot say with any exactness when the three are in one line, that is, when the line of sight is really on, and when he fires the gun, thinking they are in line, they really never are, except by pure accident. It is doubtless true that by dint of much practice this part of the error of pointing can be reduced, and with some men, who have the natural gift, it becomes very small, but no man can entirely overcome it, and very few men, no matter how long and how well they are taught, can make it even small. If, however, a telescope is substituted for the ordinary gun-sight, the difficulty of telling when the line of sight is truly on at once disappears. Instead of having three objects at different distances from the eye to bring into line, the gun-pointer has but two objects before him, the target and the cross wires of the telescope, and these are in the same plane, so that he requires no practice, nor any natural aptitude to tell when the line of sight is on. In fact, unless he be blind, he cannot help knowing when it is on.

With the ordinary sights no man can possibly say when the line of sight is exactly on, and I have no doubt but that there is a mean error of pointing of nearly one-quarter of a degree, due entirely to this cause. With the telescope sight, this error of pointing is almost entirely eliminated, and only exists at all on account of certain practical needs.

To get, with a short telescope, the 17 degree field of view which our present telescope sights give, and also to get enough light to give a clear view under disadvantageous circumstances, we have to use an object glass of great curvature, and such a lens introduces a slight error on account of imperfect focusing of the rays of light transmitted through it. This error may be observed by looking through the telescope at a distant object, when a slight motion of the eye will seem to shift the cross wires with reference to the image of the object. It is, however, only a small fraction of the error always existing when ordinary sights are used.

Nevertheless there is much opposition to the use of telescope sights in the Navy, and a discussion of the reasons for objecting to them seems in order. In the first place I am convinced, as I have already stated, that few officers fully appreciate the errors of actual gun-practice at sea at long range. This is due to the usual absence of anything near the target, by a comparison with which they can be estimated. When it is considered that the cross wire of the T-square used in measuring the lateral distance of the point of fall from the target covers a space of 10 feet as seen at 2000 yards, it will be readily understood that the actual errors cannot be closely determined, and as a matter of fact, I have no doubt that many shot which appear from the ship to have almost struck the target would, if their points of fall had been accurately fixed, prove to have passed at such a distance as would have insured their missing a battleship placed where the target was. In the next place, the mere statement that accurate pointing is impossible with the ordinary sights and easy with the telescope carries little or no weight with most people. They neither realize the errors of the first method nor believe the accuracy of the second. As a matter of fact, however, the actual errors determined by the aiming drills on the gunnery training-ship Lancaster were reduced two-thirds by the use of the telescope, and when it came to the prize firing, and the choice was offered of using either kind of sight, all but one of the entire class of seamen gunners chose the telescope sight, the one selecting the bar sight asking permission to change to the telescope before he had completed his score. The remaining objections to the telescope sight are entirely mechanical and can be overcome if the importance of doing so be once realized. With brown powder the glass is quickly coated with residue and can only be kept clear by constant wiping. With smokeless powders, this trouble should be much diminished but will still remain to a certain extent. Let it be remembered, however, that one shell which hits is worth more than any number which miss. Even should keeping the telescope glasses clean reduce the rate of gun-fire to half what would be obtained by the use of bar sights, there would be a clear gain in efficiency. More hits would be made in a given time by the slower than by the faster fire. Again, the present telescope mountings are of too light construction and cannot be relied upon to remain in proper adjustment. A single fire from one of the turret guns sometimes completely disarranges the telescope sight, and there is present to the gun-pointer the constant and often justified suspicion that his sights cannot be relied upon. Of course, such a condition is a fatal bar to efficient gun-practice, and should not be permitted to continue. Certainly no one will doubt but that perfectly reliable mountings can be, and if demanded will be devised and put in place of those now used. For my own part, I think it would pay to spend a million dollars, if necessary, to replace all our present telescope sights by others with improved mountings.

It has been objected to the telescope sight, especially for the rapid-firing guns, that it reduces the rate of fire by preventing the gun-captain from keeping the target in view. The fact that the present telescopes have a field of 17 degrees should sufficiently answer this objection. At 2000 yards range the space taken in by the telescope is a circle nearly a mile in diameter. The real difficulty is that with the telescope for the first time the gun-pointer perceives his errors and realizes the difficulty of actually bringing the line of sight on to the target. The rough adjustments which with the ordinary sights seemed sufficient to give him a good aim no longer suffice, and the consequent slower pointing is reproached to the telescope when it should really be recognized as a proof of its efficiency.

Under these circumstances, I cannot but feel sure that in course of time the prejudice against the telescope sight for naval guns will disappear. Its present mechanical features of weakness will be removed, and it will replace all other forms of sights. When this happens, even allowing an error of pointing of 5 feet due to imperfections in the telescopes, and supposing the error of pointing due to roll to be corrected to one-third, the mean errors of our heavy guns at 2000 yards range will be about 24 feet vertical and 22 feet lateral—much greater than the estimates of 9 feet and 20½ feet, which I made before taking account of the "error of pointing," but very much less than as actually determined at Santiago.

The recent English experiment with the Belleisle affords a rough means of checking some of the foregoing estimates. The Belleisle was moored head and stern, and the Majestic steamed at 6 knots on a line parallel to the Belleisle's keel, starting from a point on her quarter and 1700 yards distant, being 1300 yards distant when abeam, and completing 9 minutes' firing when about 2 points forward abeam. It was intended to steam at 7 knots, which would have brought the Majestic on the Belleisle's bow at the end of nine minutes, but on account of the lower speed, the firing ceased before the full course from quarter to bow had been traversed. The Belleisle's length is 245 feet; her armored casemate or battery is about 60 feet long, and as she was 2 feet light, the target may roughly be said to have been a central part 80 feet long by 24 feet high with the ends 60 or 70 feet long and perhaps 16 feet high. The Majestic fired 15 12-inch; about 200 6-inch; 400 12-pounder, and some 750 3-pounder shell, the respective rates of fire per gun being a 12-inch round every 2.4 min., a 6-inch every 17 seconds, a 12-pounder every 12 seconds, and a 3-pounder every 4½ seconds. The target was stationary; the distance known exactly; the speed known, and the sea presumably smooth. Consequently the errors of the gun-fire should have been almost entirely due to that part of the error of pointing which results from the use of ordinary sights and which I have stated, in my opinion, to be about one-fourth of a degree. Now a study of the diagram of hits, assuming that given by the Engineer to be correct, shows that the mean error of the Majestic's 12-inch guns was just about that much. If the mean error of pointing was one-fourth of a degree, or about 20 feet at the mean range of 1500 yards, then the percentage of hits, taking the central portion, 80 feet by 24 feet, as the target, should have been about 34, and actually there were five hits out of 15 shots fired. Again it seems that practically all the hits of every caliber were within a length of about 160 feet, there being no hits near either extreme end, and this, on the well-known principle that the mean error is about one-third the extreme error, gives a mean lateral error of about 26 feet, reasonably to be accounted for by my assumed error of pointing and by imperfect correction for speed. The size of the vertical errors too can be judged somewhat from the fact that the masts were cut and splintered by numerous hits of small shell, almost to their very trucks. There appear to have been six or seven 12-inch hits, all but one in the central part, and probably 40 per cent of the 6-inch were also hits, and while this, in my opinion, shows most excellent marksmanship, it fully bears out what I have said about the error of pointing which inevitably results from the use of ordinary gun-sights. The result of 9 minutes' firing, even with the large error of pointing, shows what a modern ship's battery can do under favorable circumstances.

Let us see what results may be looked for under the ordinary conditions of service, supposing the mean errors of the guns at 2000 yards to be 24 feet vertically and 22 feet laterally as I have estimated them to be when telescope sights are used. We may assume as general dimensions of a hostile battleship a length of 375 feet, a freeboard of 25 feet and a beam of 75 feet, which, taking an angle of fall of our projectiles of a little over one degree, gives a vertical target 375 feet wide by 27 feet high for the broadside-on position, and 75 feet wide by 33 feet high for the end-on position. Taking first the broadside-on position of an opponent, I find with the foregoing data that the chance of hitting is 34, *i. e.* 34 per cent of all shot fired from the heavy guns will strike the enemy. With the same data, but with a range of 3000 yards instead of 2000 yards, and the errors of the gun increased proportionately, the percentage of hits would be about 22. Taking next the case of the end-on position of an opponent, here we have the lateral error of our gun-fire somewhat reduced by the elimination of that part of it due to the unknown speed of the target. I have assumed that the resultant of the motions of gun and target across the line of fire can be estimated with a mean error of four knots, which would result in a mean lateral error of the gun of 20 feet at 2000 yards range, but, when the motion of the target is directly towards or away from the gun, one's own speed being known, this error should almost disappear. Consequently, in the case under consideration, while the mean vertical error of our guns is very slightly increased, say to 24½ feet, their mean lateral error is reduced, probably to 15 feet. With these data I find the chance of hitting at 2000 yards to be about 40 per cent, and at 3000 yards nearly 24 per cent.

If then I have made no seriously erroneous assumptions, the important conclusion is reached that within 3000 yards range a battleship offers a better target end-on than broadside-on, the ratio at 2000 yards being 20 to 17, and 24 to 22 at 3000 yards range. Of course the greater the errors of the gun, the more important is target *area* and the less important is the distribution of that area, and consequently as range increases the greater area of the broadside finally offers a better target than the higher, but much narrower and much smaller area of the end-on position, but the more accurate the gun-fire, and the less the range, the better the end-on target as compared with the broadside target. These figures seem to me to clearly indicate the proper course to pursue in an engagement with an opponent who endeavors to come to close quarters. Let us consider an action between two similar ships, each willing to fight, and suppose that A proposes to use his battery to its full effect, while B wishes to ram. If B simply stands directly for A, the latter brings B on his quarter, so as to have one whole battery in play and keeps him there by proper use of the helm If A's speed equals or is superior to B's, this position can be maintained just as long as B is foolish enough to keep heading for A. If, however, B has the speed, then the time during which he remains exposed to A's full broadside, while only having his own ahead fire, is limited. Suppose B has 20 knots and A only 15 knots speed, and suppose the action began at 4000 yards range. Then B, heading for A, and being kept on A's quarter by the latter's slowly turning, will be approaching A at about 10 knots an hour, and to go from 4000 yards distance to actual contact will take over 12 minutes. Under such circumstances, in my opinion, A's proper course does not admit of question. He should trust to his gun-fire, and if he did not disable B in that 12 minutes, it would be a very remarkable thing. What more could be asked than to have an enemy end-on for 12 minutes under your own maximum fire, at ranges steadily decreasing, and on a constant bearing, and, to cap the climax, to have your enemy meanwhile able to use but a fraction of his battery. Remember that B must actually reach A to bring the ram into play, and that as the distance diminishes, the percentage of hits for the guns rapidly rises.

Let A be the Kearsarge and B a five-knot faster Kentucky—during the 12 minutes approach A uses four 13-inch, four 8-inch and seven 5-inch guns against two 13-inch and two 8-inch for B—which would have the worst of it, and who can believe that B would not, long before reaching A, put his helm over and assume a more equal position. Of course this would be much more the case if a less difference of speed existed, as would be most likely. If I am right, then A's attitude, assumed because it gives him the maximum battery power, will compel B to relinquish the idea of ramming and to accept a test of battery against battery as A desires. Any other method of approach will keep B under A's full fire for longer than 12 minutes, and if B tries to keep his full battery bearing while approaching, over half an hour's gun-fire at decreasing ranges will have settled the action before the ram can come into play.

But doubtless you will say that such small errors, such large percentages of hits, as I have assumed to result when efficient telescope sights are used have never been found in past practice, nor is it likely that they will be in future, at least under battle conditions. Let us see if there are any reasons why we cannot expect to attain in practice the results deduced from theory, and first let us re-examine briefly the causes of error thus far discussed.

Considering first lateral errors, it is evident that the combined effects of accidental deflections due to the gun itself, of inclination of the axis of the trunnions due to rolling or pitching, and of wind across the line of fire, are unimportant.

In fact, their resultant is a lateral error of less than 6 feet at 2000 yards range, while the one remaining cause of lateral error—motion of gun and target—may easily introduce a mean error of 20 feet. Indeed, my assumed mean error of 20 feet supposes combined speed of gun and of target across the line of fire to have been estimated within four knots and allowed for in pointing, and, while this error may not be exceeded on the average, yet, if no attempt is made to estimate accurately and allow for motion of target across the line of fire, the error due to this cause is likely to be much greater than I have assumed. This, at all events, is the prime factor which determines the mean lateral error of gun-fire.

As far as vertical errors are concerned, there are two so great as to render all others insignificant. First and most important is the error due to motion of the ship during the interval between willing to fire and actually firing a gun. This error, if uncorrected, will have a mean value of some 63 feet, and consequently it is of the utmost importance to train the gun-pointers to allow for it. I have assumed that it can be corrected to one-third; so that its mean value will be only 21 feet, and that this excellence can be attained by the average gun-pointer as a result of training and practice I have no doubt.

Next in importance is the error due to incorrect measurement or estimation of the range. It is said that good judges can tell distances within 15 per cent, and if no instruments are used, I suppose that the mean error in range should be taken at 300 yards instead of the 100 yards I have assumed. If so, the vertical error due to this will be about 20 feet instead of 7 feet. If, however, as I think we must assume, there be some means of measuring range besides the unaided eye, a mean error of 7 feet is, in my opinion, an ample allowance for wrong setting of the sight bar, especially in view of the flatter trajectories of the latest type guns. This re-examination of our premises, then, has shown that the accuracy of naval gun-fire depends upon three factors: 1st, and most important, upon how closely the gun-pointers can allow for their personal errors; 2d, upon how accurately we can determine the range; and 3d, upon how nearly we can estimate and allow for speed of target across the line of fire. Provided reasonably efficient means are used to limit these three errors, the practical results of gun-fire under service conditions should not differ materially from the theoretical results which I have deduced. We can, then, I believe, attain such an excellency in gun-practice by dint of constant and intelligent effort that, even in the heat and excitement of battle, the percentage of hits will at least approach that which would result from the mean errors I have calculated; we need not, and I hope never again will, make such a poor showing as we did at Santiago.

Let us consider what conditions are necessary to attain this excellency.

1st. Every gun should be fitted with a telescope sight, and so fitted that it can be relied upon to remain in adjustment and not be thrown out by any number of firings of the gun itself. This can certainly be accomplished and will by itself remove one of the greatest causes of errors in gun-fire.

2d. Every gun-pointer must be taught to make a proper allowance for his personal error. It is very important that he should learn by constant practice to manipulate his gun with rapidity and accuracy, but above all he must learn by actual firing just when to try to fire in order that the line of sight may be on when he really fires. He must learn to really use the telescope sight; to keep his eye to it so as to see where the line of sight is when the gun goes off. One of the great causes of bad shooting is the drawing back of the gun-pointer from the telescope just as he fires, or even, in many cases, before firing. A rubber shield or cover for the eye-piece ought to sufficiently mitigate the effects of the backward jump of the telescope when the gun is fired to overcome the men's hesitation to keep their eyes near enough to see clearly at the actual moment of firing. Sub-caliber practice, under various conditions of the sea, and pointing and snapping primers at a target, should be of great value in training the gun-pointers to correct their personal errors. If the roll is considerable, and at all regular, accuracy of fire will be greatly increased by so pointing that the line of sight comes on near the end of the roll when the ship is almost stationary, and when suitable conditions exist, this method should be practiced, but motion in a seaway is usually so irregular that too much time would be lost in attempting it. The good marksman must be able to make an allowance suited to the greater or less speed with which his line of sight is approaching the target. Probably an average correction at 2000 yards range will result from willing to fire when the lower edge of the horizontal wire of the telescope reaches the upper line of the enemy's freeboard on a downward roll, or when the upper edge of the wire reaches his waterline on an upward roll, but each man must learn to make an allowance suited both to his own personal errors and to the rate of angular motion as his line of sight comes on.

3d. Officers, and gun-pointers too, should learn to estimate and allow for the motion of the target across the line of fire, in order to reduce to a minimum the greatest cause of lateral error; and every available means should be used to accurately determine range, in order to similarly reduce the greatest *remaining* cause of vertical error.

As regards the estimation and correction for motion of target across the line of fire, I think it would be a great improvement to put marks on the horizontal wire of the telescope sight corresponding to speed corrections. This would enable the correction to be made within as close limits as the speed to be corrected for can be estimated. Of course the speed of one's own ship in action should be known, and the gun-pointer should be taught to make *accurate* allowance for it, and the speed of the enemy across the line of fire should be reduced to nothing, as far as possible. A nearly constant bearing of the enemy with respect to one's own course will add greatly to the efficiency of gun-fire, and to maintain such a constant bearing should be one of the most important objects of manœuvring in action.

I think it would be very desirable to develop this method in target practice by firing while steaming on a spiral course, either approaching or receding from the target. Under such conditions, were the target an opposing ship, there would be no error caused by his unknown speed, and the error caused by one's own speed would be a constant depending upon the angle which the course made with the line of bearing of the target, and consequently susceptible of previous calculation for any given speed and angle.

As regards measurement of distances, no thoroughly reliable range-finder has yet been devised, and the determinations made by a rapid-firing gun, though much better than mere judgment of the distance, are, in my opinion, almost certain to be greatly in error.

Perhaps the old telemeter in a more modern form would prove sufficiently accurate for such work. At all events, I hope it will be tried, and am sure that under some circumstances it would be of great value. I refer to the stop watch graduated in distances, by which the time interval between the flash and the report of a hostile gun is measured, and the corresponding distance read off. The objection is made to this device that it will be difficult to surely connect a given flash with the corresponding sound, but by careful observation of the larger guns of an enemy, I should think this might be overcome. Certainly to a man shut up in a turret and cut off from outside information by any cause, this instrument might be of great value, as giving a possible means of measuring range.

But there is one more important means of adding to the efficiency of a ship's battery, and that is to so manœuvre her in action as to help the gunners, not so as to handicap them.

At Santiago, the necessity of preventing the escape of an enemy supposed to be of superior speed, caused the adoption of tactics which could not but have a most injurious effect upon the accuracy of our gun-fire.

During the first and most important part of the engagement, when the Spanish ships were coming out and our ships were gathering way and increasing speed as rapidly as possible, the distances changed with such rapidity that I have no doubt but that the gun-sights were set with a mean error of many hundred yards. Moreover, the course of the enemy, his unknown speed, our own varying speed and rapid turning under the action of the helm must have introduced great lateral errors. These facts, together with the imperfections of the sighting apparatus, the smoke, and the unexpectedness of the sortie combined to affect the accuracy of our fire and account for the remarkably small percentage of hits. Who can doubt that an enormous increase in this percentage of hits would have resulted from a change in conditions which allowed of a steady bearing and a constant or slowly varying range of the enemy?

The advantages which come from keeping the enemy on a bearing which makes a constant angle with our own course are greater, perhaps, than would appear at first sight. In the first place the lateral error due to the unknown speed and course of the enemy is entirely eliminated. But, secondly, the angle of train being constant, the firing will be more rapid and more accurate, for the reason that the line of sight will pass across the target at each roll, thus enabling the gun-pointer to pay entire attention to his elevation. With a constantly changing bearing of the enemy, on the other hand, if the line of sight comes on in train at one roll, it is likely to be entirely off the target at the next, and the gun-pointer has the doubly difficult task of simultaneously adjusting both train and elevation.

A constant, or at least but slowly changing, distance, too, is a great help to accurate gun-fire, as it enables the range to be estimated and the firing corrected by observation of the points of fall of the shot.

Of course an equal advantage accrues to one's opponent from such conditions, and where an enemy trusts equally with oneself to his battery, and asks nothing better than to oppose broadside to broadside, it may be a question whether to accept the gage or, by manœuvring, to endeavor to gain some advantage of position. But it is when the enemy, trusting to other weapons, fails to take the equal advantage which lies open to him, that the opportunity comes to develop one's gun-fire to its maximum by manœuvring solely with a view to *its* efficiency. The skill and discipline of the men behind the guns, the results of constant and unsparing efforts in preparation for the decisive moment of action must always be the principal factors in success, but the skill with which the commanding officer handles his ship so as to keep the maximum number of guns in play; to keep the enemy on as nearly constant a bearing as possible; and to avoid rapid changes of distance, will give victory over an otherwise equal opponent.

[NOTE.—Discussion on this article is invited, to be published in succeeding numbers.—EDITOR.]

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

OUR NEW BATTLESHIPS AND ARMORED CRUISERS.

By D. W. TAYLOR, Naval Constructor, U. S. N.

The six armored cruisers and five battleships for which bids were advertised to be opened on December 7, 1900, not only constitute the largest single addition to our armored ships ever advertised for at one time, but each one of these eleven vessels is larger than any vessel of our navy now built or building.

The following remarks refer entirely to the designs prepared by the department. The bidders are allowed to submit their own designs and incorporate in them any and all features of the department's designs. With the advantage of full information concerning the department's designs to start with, and a free hand, in some respects, where the department's designers are handicapped, it is to be hoped that the contracts will be ultimately awarded for vessels somewhat superior to those herein described.

Figs. 1, 2 and 3 show the general features of the eleven armored vessels in question, and Table I gives their dimensions and various other data concerning them. Three of the battleships are to be sheathed and two unsheathed. In view of the department's decision that three of them should have two superimposed 8-inch turrets and the other two the 8-inch turrets in a quadrilateral arrangement, the superimposed arrangement was applied to the three sheathed battleships. As the sheathed and unsheathed armored cruisers are alike in every particular, except as to the sheathing and the minor differences in stem, stern post and other fittings incident to sheathing, it is not thought necessary to give separate plans for the sheathed and unsheathed vessels.

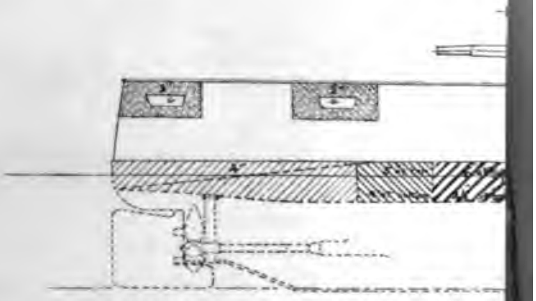
The most obvious fact in connection with these vessels is their very great size as compared with any of our earlier vessels of similar types. Our last armored cruiser was the Brooklyn, of 9215 tons displacement; whereas the Maryland class are of 13,400 tons. The three vessels of the Maine class, our last battleships, are all under 12,500 tons displacement, while the new unsheathed battleships are 14,600 tons.

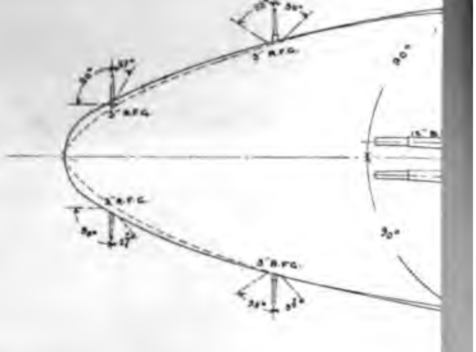
When we come to compare these battleships and armored cruisers—not with our former vessels, but with each other—the question at once arises whether it is worth while to continue to build armored cruisers inferior to battleships in so many respects and superior to them in so few. Some light upon this question may be afforded by a consideration of the genesis and the development of the armored cruiser.

I believe the first armored cruisers were the Imperieuse and Warspite, in the English navy. These vessels were designed in the early '80's as "Armor-plated Cruising Ships." They were sheathed and coppered, had a large amount of sail power, and while properly classed as "Armored Cruisers," they can hardly be regarded as the forerunners of the armored cruisers of to-day. I think that the first vessels designed with a view to fulfilling the functions expected to-day of the armored cruisers, were the seven English belted cruisers of the Aurora class, completed in 1888 and 1889. These vessels were often called the belted Merseys—following after the four vessels of the Mersey class, completed about four years before them. The vessels of the Mersey class were protected cruisers, 300 feet long, 46 foot beam, having a little less than 20 feet mean draught, a little over 4000 tons displacement, about 6000 H. P., and about 17 knots speed. They had a coal capacity of 900 tons. Their battery consisted of two 8-inch, ten 6-inch, three 6-pounders, and smaller guns.

The seven vessels of the Aurora class were 300 feet long, 56 foot beam, 22 feet 6 inches mean draught, 5600 tons displacement 8500 I. H. P., speed a little over 18 knots, coal capacity 900 tons, armament, two 9.2-inch guns, ten 6-inch guns, six 6-pounders, ten 3-pounders, and other minor guns.

The Mersey class had a protective deck from 3 to 2 inches thick, and no armor. The Aurora class had about the same deck protection, but carried a 10-inch partial belt of compound armor, and some armor protecting the guns. Comparing them with the Mersey class they would seem to have 1600 tons (or




3" R.F.G.
3" R.F.G.
3" R.F.G.
3" R.F.G.
90°
90°

nearly 40 per cent) greater displacement, to have more than a knot greater speed, the same coal capacity, and a materially heavier battery and armor protection. They cost about 30 per cent more. Clearly, these vessels could be expected to find their greatest field of usefulness in attacking and destroying the protected cruisers of the day, which were smaller, weaker and slower.

As the type developed and the size of protected cruisers increased, it became more and more difficult to build armored cruisers which would be superior to the protected cruisers in armor, armament, and speed. The speed dropped back until it was less than that of the protected cruiser. An illustration of this is furnished by our own navy, when comparing the New York and Brooklyn and the Columbia and Minneapolis, of almost the same date. The armored cruiser then came to be regarded as a light, fast battleship, a vessel smaller and handier than the battleship, having less battery and armor, but making up for this defect by superiority in speed and coal endurance. In its latest development the armored cruiser has increased in size until it is practically as large as the battleship, and it would appear that the time is now about ripe for the settlement of the question whether the type shall survive or be merged into the battleship proper.

Compare, for instance, the vessels of the Maryland class with the Virginia and Rhode Island (Table I). The Maryland has but 8 per cent less displacement than the Virginia. She is 15 per cent longer, and has slightly greater freeboard—offering a larger target. She draws 6 inches more water. She is decidedly inferior as regards the battery and its protection, carrying about 840 tons of battery and ammunition (with full supply of ammunition), as against 1417 for the Virginia. The armor on her side is not only thinner, but has a less extent, absolutely, and a very much less extent, relatively, considering the side of each vessel. From the water-line to the main deck the Maryland has 4355 feet, or 45 per cent covered by armor; the Virginia has 4775 feet, or 60 per cent covered by armor. The total weight of armor on the Maryland is a little over 2000 tons, as against more than 3400 on the Virginia. The bunker capacity of the Maryland is 2000 tons, as against 1900 for the Virginia—a gain of more than 5 per cent. But as the Maryland has nearly 2 per cent greater wetted surface than the Virginia, and as her more powerful engines will waste more in friction at a 10-knot speed than those of the battleship, it may be said that the two have practically the same coal endurance at 10 knots. The sole point of superiority of the Maryland is the 3 knots greater trial speed —22 as against 19. In this connection, it may be desirable to attempt to appraise the advantage the Maryland may be expected to have over the Virginia in speed in other than trial conditions. Evidently, under the same conditions each may be expected to develop the same fraction of its maximum indicated horsepower. While the indicated horsepower curves of these vessels are not yet known, they can be estimated fairly well from experiments made at the model basin, and from such experiments the diagram shown in Fig. 4 has been determined. The estimated maximum indicated horsepower in each case is reduced to a line of the same length and speed curves drawn with fractions of maximum I. H. P. as abscissæ and speed as ordinates.

All things considered, it appears probable that under the conditions of service a man-of-war cannot expect to average for a long period of time, say seven or eight days, more than from 50 to 60 per cent of the maximum I. H. P. maintained on trial. Under these conditions the Maryland would have about 2 knots advantage in speed over the Virginia, while for a short spurt she may reasonably be expected to maintain the 3 knots of the original trial.

Probably some members of the Institute may be surprised that the Maryland, so nearly the same size as the Virginia and superior only as to speed, should be so inferior in other respects. The general tendency is to regard the question merely as one of weights; that is to say, if it were desired to make the Iowa a 19-knot ship it would simply be necessary to reduce the weight of battery and armor and put it into machinery. As a matter of fact, it would be necessary to assign not only greater weight to the machinery, but greater space, rendering it necessary to lengthen the vessel, and indirectly causing much more weight to be carried than the additional machinery. The estimated weight of the machinery of the Virginia is 1796 tons; that of the Maryland is 2135 tons; or but 339 tons more. Owing largely to the greater length, however, the hull of the Maryland, including the protective deck, weighs nearly 400 tons more than that of the Virginia. The Virginia, then, being 1200 tons smaller, has to carry more than 700 tons greater weight of hull and machinery. The coal and miscellaneous weights are practically the same, so that

the Maryland class must carry about 1900 tons less of armament, ammunition, and armor. At normal displacement, the total weight of armament, ammunition (two-thirds full supply) and armor is 1912 tons less upon the Maryland than upon the Virginia, according to present estimates.

After careful consideration of these two types, it seems to me that the time has come to ask some such questions as the following:

First.—Taking into account the fact that with the completion of ships now authorized we shall have six large armored cruisers of 22 knots speed and five smaller ones of practically the same speed,[1] are we warranted in continuing to build at the same time vessels of so nearly the same size and cost, and differing so widely in other respects, as the Maryland and Virginia?

Second.—If the superior speed of the armored cruisers is of such value as to warrant our continuing to build Marylands side by side with Virginias, would it not be more consistent and logical to increase again the speed of the battleship to, say, 21 knots, without reducing its offensive or defensive powers? This would involve a material increase in size, probably to 1700 tons or so trial displacement, and an increase in cost of probably 12 to 15 per cent.

Put into another form the questions above may be reduced to one.

For a given expenditure of money we can probably build four Virginias and five Marylands, or eight Virginias, or seven enlarged Virginias of 21 knots trial speed. At the present time which course would be the best to follow?

This question must be answered ultimately by the sea-going officers of the service. This paper will have served its purpose if it results in bringing out the views of some of the many officers whose views have the weight of authority. It is earnestly to be hoped that the development of the navy during the next five years will not be along lines which will be generally recognized as not the best at the end of that period.

NOTE.—Discussion on this article is invited, to be published in succeeding numbers.—EDITOR.

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[1] NOTE—I include as armored cruisers the three protected cruisers now advertised by the department, because they are practically improved Brooklyns.

TABLE I.—DATA FOR BATTLESHIPS AND ARMORED CRUISERS.

	BATTLESHIPS.		ARMORED CRUISERS.	
	Pennsylvania, New Jersey. Georgia. (Sheathed.)	Virginia, Rhode Island.	California, Nebraska, West Virginia. (Sheathed.)	Maryland, Colorado, South Dakota.
Length on load water line	435′	435′	502′	502′
Length over all	441′ 4″	441′ 4″	504′ 9″	504′ 9″
Beam extreme	76′ 10″	76′ 2½″	70′	69′ 6″
Draught mean trial....	24′	24′	24′ 6″	24′ 6″
Displacement in tons, normal................	15000	14600	13800	13400
Speed on trial, estimated knots......	19	19	22	22
Indicated horse power on trial (Est.)........	19000	19000	23000	23000
Freeboard forward, normal................	20′	20′	23′	23′
Freeboard aft, normal	19′ 3″	19′ 3″	21′ 6″	21′ 6″
Wetted surface, sq. ft.	42313	41800	42843	42430
Deep load draught, mean	26′	26′	26′ 6″	26′ 6″
Armament—				
Main battery.......	4 12″ B. L. R. 8 8″ B. L. R. 12 6″ R. F.	Same as sheathed battle-ships.	4 8″ B. L. R. 14 6″ R. F.	Same as sheathed cruisers.
Secondary battery.	12 14-pdr. R. F. 12 3-pdr. R. F. 4 1-pdr. (Aut.) 4 1-pdr. R. F. 2 mach. guns 6 Colt (Aut.) 2 3″ R.F. field		18 14-pdr. R. F. 12 3-pdr. R. F. 4 1-pdr. (Aut.) 4 1-pdr. R. F. 2 mach. guns 6 Colt (Aut.) 2 3″ R. F. field	
Torpedo tubes	2 submerged	2 submerged	2 submerged	2 submerged
Heavy guns forward, above L. W. L.	12″—26′	12″—26′	8″—26′ 3″	8″—26′ 3″
Heavy guns aft, above L. W. L.	12″—26′	12″—26′	8″—26′ 3″	8″—26′ 3″
Thickness of W. L. belt amidships, top	11″	11″	6″	6″
Thickness of W. L. belt amidships, bottom...	8″	8″	5″	5″
Total depth of belt	8′	8′	7′ 6″	7′ 6″
Thickness lower case-mate	6″	6″	5″	5″
Thickness upper case-mate	6″	6″	5″	5″
Thickness of fronts heaviest turrets......	11″	11″	6½″	6½″
Thickness of sides heaviest turrets.....	9″	9″	6″	6″
Thickness of slopes of protective deck......	3″	3″	4″	4″
Thickness of flat of protective deck......	1½″	1½″	1½″	1½″

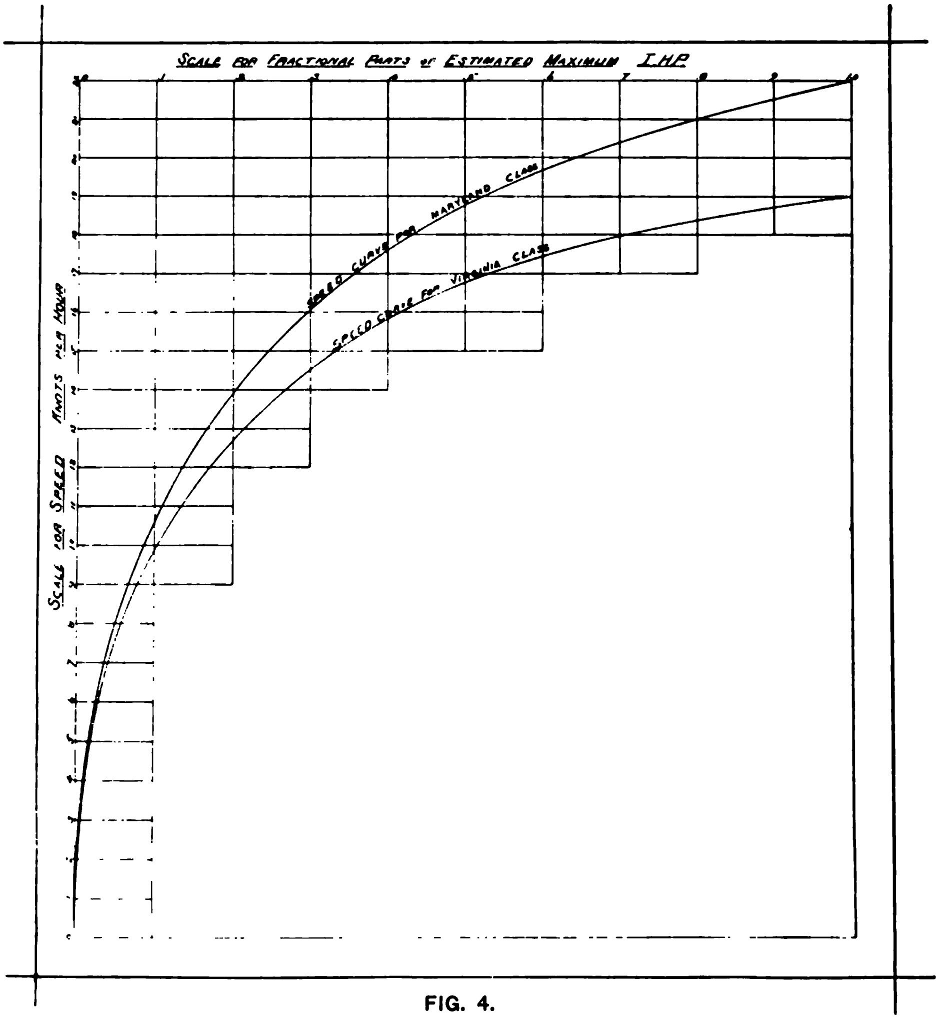
SCALE FOR FRACTIONAL PARTS OF ESTIMATED MAXIMUM I.H.P.
0
1
2
3
4
5
6
7
8
9
10
SCALE FOR SPEED KNOTS PER HOUR
SPEED CURVE FOR MARYLAND CLASS
SPEED CURVE FOR VIRGINIA CLASS

FIG. 4.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE INFLUENCE OF SUBMARINE CABLES UPON MILITARY AND NAVAL SUPREMACY.

By GEORGE OWEN SQUIER, PH. D., Captain Signal Corps, U. S. V.

The accidental non-delivery of two cable messages from the Minister of Marine (Bormejo) to the commander-in-chief of the Spanish squadron (Cervera), at Martinique, undoubtedly largely changed the whole history of the Spanish-American war.

One of these telegrams informed the Admiral of coal supply near at hand, and the other granted him permission to return at once, with his squadron, to Spain.

Admiral Cervera's firm stand against the dispatch of the Spanish squadron from the coast of Spain to West Indian waters is heroically and almost pathetically shown in the recent publication, by permission of the Queen Regent, of the official despatches. At Cape Verde, and before and after, by cable and by letter, he points out the unpreparedness of his squadron, and predicts its certain destruction if it proceeds. Knowing his strong views on this point, it is probable that he would have lost no time in coaling and starting back to Spain.

With Cervera's squadron returned to Spain, there would have been no Santiago campaign, the Flying Squadron would probably have been sent to the coast of Spain, and the land operations in Cuba directed against Havana.

Cervera's fleet not eliminated, who can say how long Spain may not have been able to resist, and what additional blood and treasure the struggle may have cost the United States.

The story of the Spanish-American war is largely a story of "coal and cables." That war for the first time demonstrated the dominating influence of submarine cable communications in the conduct of a naval war. As a result of it, the principal maritime powers, with colonial possessions, are each at present elaborating their "Cable Policy," and have awakened to a realization of the fact that reliable submarine communications under exclusive control are not only absolutely necessary, but exercise a dominating influence upon the control of the seas, whether in commercial strategy or in military and naval strategy.

A modern war between two naval powers has reduced itself largely to a war of "coal and cables."

At present the submarine telegraph is a powerful instrument of war, more powerful, indeed, than battleships and cruisers, since by wonderful and instantaneous communications of thought, it brings distant countries and colonies together in sympathy, which is the only true and permanent tie.

ELECTRICITY THE IDEAL MEANS OF TRANSMITTING INTELLIGENCE.

The triumphs of science in the last half century have been no where more exemplified than in the enormous strides made in the facility of transmitting intelligence. The mails, the telegraph, and the telephone are civilizing the world. Perfect as is the mail system of to-day, a monument to organization, yet, its swiftest messenger—steam—is so far outstripped either on land or sea by the practically instantaneous electric current, that the tendency year by year is to put more of the world's business "upon the wire."

Time has an international money value in trade, and a paramount strategic value in war. The fastest mail express, or the swiftest ocean ship, are as naught compared with the velocity of the electrical impulse, which practically annihilates any terrestrial dimension. As the distance increases, electricity surpasses steam in a continuously increasing ratio. With a message to be sent half way around the earth, the minutes required by the telegraph, run into weeks and months by the slow process of the mails. Steam time is directly a function of the distance to be traversed, and from the nature of things must require twice as long to go two miles as one. If, then, the cable saves six days between Europe and America, it will save more than twice this time between America and the East, and is from this point of view correspondingly important and necessary. Since electricity so far outstrips any other known vehicle for transmitting intelligence, it must eventually carry all the most important of the world's information.

Strategy has been defined as, the science of combining and employing the means which the different branches of the art of war afford, for the purpose of forming projects of operations and of directing great military or naval movements; the art of moving troops or ships so as to be enabled either to dispense with a battle or to deliver one with the greatest advantage and with the most decisive results.

* * * * * * * * *

It is believed that the more the foundations of successful strategy are analyzed, both as the science of conceiving military plans and as the art of executing the same, the more it will become clear that the strategist who is possessed of the most efficient and reliable means of obtaining and communicating information, both of the enemy and his own forces, will have a paramount and insuperable advantage.

Maritime nations are at present beginning to realize that it is not ships and coaling stations alone which measure naval strength, but also reliable and efficient means of directing, concentrating, supplying, or withdrawing those ships upon the great strategic chess board of the sea.

Lord Charles Beresford, in January, 1888, declared that, in time of war, the cutting of cables would make it impossible for chiefs of squadrons of distant stations to receive communication of the plan of campaign, and that they would no longer know where to find coal nor upon what protection to count.

Nor is this means required for securing true information only, but also for the equally important rôle of disseminating misinformation, since deceiving the enemy has always been an important means of strategy.

If there have been any doubts of the dominant influence of land and submarine cable communications as a military and naval necessity, they would be completely dispelled by the present unparalled situation in China, in which the rest of the entire world has been kept in ignorance for a period of a whole month, by the lack of adequate communications under control.

As a means of communication over great distances at sea, nothing compares, at the present state of practical science, with the submarine cable. The nation with exclusively controlled submarine communications, not possessed by an adversary, has an organized service of surveillance, which is not only important during actual war, but which may and will prove a powerful weapon in the diplomatic and preparatory conflict, which always precedes a declaration of war, and these communications are a means of securing a first *real victory*, even before war has been formally declared.

It may be said, therefore, *that the very foundation of successful naval strategy is efficient and exclusively controlled communications, and the lack of them more serious than inferiority in ships.*

As soon as the possibility of communicating at long distance, by means of submarine cables, was practically demonstrated, England understood what commercial and political preponderance the creation of a great network of cables, resting under her control, would give her.

Without letting herself be discouraged by heavy losses in the beginning, with a perseverance worthy of admiration, she has succeeded in creating and developing, methodically and without delay, a network of submarine telegraphic cables, which to-day encircles a large part of the entire world.

The English cables, up to the present, have been laid principally by private companies, but Article 7, of the conditions which govern them, provides that all official despatches shall have precedence over others; Article 3, that the companies can have no foreigners among their employees, nor can the wires pass into a foreign office, nor under the control of a foreign government, and Article 9, that in case of war the government can occupy the different stations and place its own employees therein.

During the past two years, however, there has been a great national protest in England and her colonies against the exorbitant rates imposed by the monopoly of the private cable corporations, until the principle of absolute state ownership has come to be a controlling one in England's future cable policy.

THE IMPERIAL CABLE SYSTEM OF GREAT BRITAIN.

England's sea power is not alone measured by the number, character and tonnage of her warships, it is immensely increased by the system of exclusively controlled submarine cable network, at present including nearly four-fifths of all the cables in the world, woven like a spider's web to include all her principal colonies, fortified ports, and coaling stations.

Although submarine cable communication is scarcely fifty years old, yet the British Empire is already bound together in one vast intelligence transmission system, with London as its center. Nothing important can happen at any quarter of the globe which does not find its way to this great world's news exchange—London. And this system is and has been a principal element of her strength, and has largely made possible a government including subjects naturally widely differing in character, habits, and modes of thought.

The colonist in New Zealand or in British Columbia can read each morning what was said in Parliament the day previous upon any subject important to British interests.

This great cable system, as at present existing, is the more important from our present standpoint, since no other country has such a system, and this fact has placed in the hands of the British Empire a powerful means of real dominion over the rest of the world. Nor is England satisfied with her present extensive telegraph system of world control, she has in projection for the very near future, an extension of this system, which will be nothing less than a British imperial telegraph system encircling the entire globe.

A pioneer advocate of a British imperial cable system has been Sir Sandford Fleming of Canada.

It was early discovered by every country in Europe that so efficient and valuable a servant to trade and commerce, so important an aid to the state itself, as the telegraph, should become a national institution. Great Britain, France, Austria, Prussia, Russia, Sardinia, Italy, Spain, Portugal, and Belgium, each established a state telegraph system. Thirty years ago the English telegraph lines were transferred to the state, and experience has shown that this has been done with advantage to the state itself and benefit to the public at large. At the present moment the British Empire is advancing rapidly to the accomplishment of a state controlled cable system. Imperial penny postage having been recently realized throughout the British Empire, the next great step in imperial development along this line is to connect the state-owned land telegraph systems of the Empire by a state-owned and controlled system of submarine cables. An essential and necessary condition which has guided in the conception and realization of this cable system, has been that none of the lines shall touch foreign soil. So important has been this principle in the proposed British-Pacific cable, that we find Great Britain, for some years past, anxiously negotiating for sovereignty over an insignificant island in the Hawaiian Group upon which to land her proposed cable to Australasia; and failing in this, we find her boldly ready to lay a single span of cable of over 3500 nautical miles in length, from Vancouver to Fanning Island, for the sole imperial reason that the cable shall touch only soil exclusively owned and controlled by Great Britain. This principle will be bought, in this case, at the price of permanently placing at a disadvantage British cable traffic in the Pacific; since, as will be pointed out later, the United States, by the annexation of the Hawaiian Islands, can reach the East across the mid-Pacific by cables having no single span longer than the present Atlantic cables, and yet adhere to the same principle of landing only on territory belonging to the United States.

British Pacific Cable.

England at present has direct telegraphic connection with Vancouver, with wires independent of any foreign power, since practically all of the Atlantic cables landing at Newfoundland, or Nova Scotia, from the coast of Ireland, are under British influence, and in connection with the Canadian Pacific telegraphic lines, therefore, furnish England with direct communication to the west coast of North America.

The proposed British-Pacific cable has been prominently before the British government as an imperial measure for a number of years. It has been the subject of colonial conferences, and of exhaustive research by a Pacific Cable Commission. Its construction is now assured beyond a reasonable doubt. The route is from Vancouver to Fanning Island, thence to Fiji Island, thence to Norfolk Island, and from thence by two branches to New Zealand and the eastern coast of Australia. The land lines of Australia would then complete telegraph connection with the western coast. In the Indian Ocean it is proposed to connect West Australia to Cocos Island, and then to Mauritius, and from thence to Natal and Cape Town. Cocos Island is further to be connected with Singapore by a branch cable. Singapore being already in connection with Hongkong by an all-British cable. Another branch is also proposed from Cocos to Ceylon. At Mauritius a connection would be formed with the existing cable at Seychelles, Aden, and Bombay. In the Atlantic Ocean, in order to avoid the shallow seas along the west coast of Africa, Spain, Portugal, and France, a cable from Cape Town, touching at St. Helena, Ascension, and St. Vincent as mid-ocean stations has been laid within the last few months. Its construction was hastened after the outbreak of the Boer war, to furnish an alternate British route to South Africa by the West Coast. It is further proposed to extend the cable from Ascension to the British Island of Bermuda, perhaps touching at Barbados, as a mid-ocean station.

At Bermuda a connection would be formed with the cable already existing to Halifax, and at the latter point with the Canadian and trans-Atlantic lines. The extension of the above cables in the Pacific, the Indian, and the Atlantic Oceans, would involve the expenditure of something like £6,000,000 sterling, and the laying of about 23,000 knots of new cable. With the equipment and experience which Great Britain has had in cable laying, these new cables can be manufactured and laid by England in a very short time, and there can be little doubt but that this extension of British cables, if not along the exact line above specified, yet with slight variations, will be an accomplishment of the near future.

With this extension of imperial cables added to her already extensive state-owned land line system, England will have the most complete telegraphic system in existence, placing each of the following fortified and garrisoned coaling stations in direct connection each with any other station, viz.: Hongkong, Singapore, Trincomalee, Columbo, Aden, Cape Town, Simons Bay, St. Helena, Ascension, St. Lucia, Jamaica, Bermuda, Halifax, Esquimalt, King George's Sound, and Thursday Island. The following "defended ports" would likewise be connected, viz.: Durban, Karachi, Bombay, Madras, Calcutta, Rangoon, Adelaide, Melbourne, Hobart, Sydney, Newcastle, Brisbane, Townsville, Auckland, Wellington, Lyttletown, and Dunedin.

Since with the completion of the cable across the Pacific the last telegraphic gap will be completed around the earth; it will give the great advantage of duplicate routes, since from any point there will be then two routes—one east and one west—to any other station.

PROPOSED COLONIAL TELEGRAPH SYSTEM FOR THE UNITED STATES.

The objects and benefits of intercolonial cable communications are well recognized. Since the events of the Spanish-American war the supreme importance of exclusively controlled communications, as a means of military and naval warfare, has been realized as never before. All the principal nations are studying this subject in its various aspects, and already a distinct cable policy is entering into the politics of the principal countries possessing colonies, and seeking for commercial, military, and naval supremacy. Having examined briefly the principles and present benefits of the British imperial telegraph systems, it is clear that the United States will be wise to recognize this important subject, and not delay in laying a system of submarine cables, under the exclusive control of the United States, which will not only place every part of our new possessions in direct communication with one another by the best means of intelligence transmission, but will complete the system by deep-sea cables, directly connecting these possessions to the mainland of the United States.

In this connection it may be of interest to note briefly what has been the telegraph policy, up to the present, in dealing with the territory of our new possessions. In Cuba and Puerto Rico, and in the Philippine Archipelago, every effort has been made by the Signal Corps of the army to cover the islands with a network of wires, so complete and reliable that intercommunication is insured at all times. In the pacification of Cuba and Puerto Rico, in the suppression of the Philippine uprising, it is believed that there has been no more potent agent than the military telegraph.

For years Spain had been trying to pacify the Island of Cuba and yet her telegraph system was incomplete, obsolete, and unreliable in the extreme. It was possible for bands of insurgents to move about much at their pleasure, appearing here and there, with no means of locating or concentrating for their distruction. It was not that the number of troops was not sufficient, so much as it was that there were no efficient means of directing the troops in such a way as to make results decisive.

PHILIPPINE MILITARY TELEGRAPH SYSTEM.

During the Philippine war the utility of the military telegraph has been most forcibly illustrated.

It has been assumed, as a principle from the outset, that the quickest means of pacifying and civilizing the Philippine Archipelago is to cover it with a network of telegraph wires. A given district, with adequate telegraph communications, can be guarded with less than half the troops than when such communications are wanting. Commanding officers can crush an incipient uprising suddenly, and before it has time to assume dangerous proportions, by concentrating, by telegraph, the garrisons from all directions upon the one point involved. Already there are about 2500 miles of land telegraph lines in operation in the Philippines, and about 260 miles of inter-island and lake cables have been laid, while a cable-ship transport, carrying four hundred miles of additional deep-sea cable, will leave New York for the Philippines within the next two months. At the last report, the telegraphic messages in the Island of Luzon alone exceeded 6500 per day, averaging over 40 words each, or approximately 260,000 words daily. As an illustration of the absolute necessity of telegraphic and cable communications in the work in the Philippines, it may be added that the telegraph is practically the only mail service that exists, and that recently while the English cable from Manila to Iloilo was interrupted by earthquakes for a period of six weeks, it was impossible to communicate with the southern islands. About three weeks ago a battle was fought at Cagayan, in the island of Mindanao, in which 150 American soldiers met with one of the heaviest resistances yet experienced in the Philippines. Owing to the lack of telegraphic communications, and lack of boat transportation, nothing was known as to the fate of these men for over two weeks.

A comprehensive and progressive scheme of land lines and inter-island cables, embracing the entire Philippine Archipelago, is rapidly being constructed. Already the Department of Northern Luzon is well covered with lines, reaching from Manila to the northern extremity of the Island.

Two trunk lines have been established—one along the west coast, the other along the Rio Grande de Cagayan river. The islands of Cebu and Loite have been connected by cable, and a complete new route from Manila to Iloilo will soon be in operation, furnishing a duplicate route to the present English cable direct from Manila to Iloilo. In the Department of Mindanao and Jolo, the plan involves direct communication, by cable, between the principal islands, and by land lines and cable to the telegraph system in the Department of the Visayas, and from thence by duplicate routes to Manila.

THE ALASKA TELEGRAPH SYSTEM.

The growing commercial importance of Alaska, and the prospective future of that country, as indicated by the best experts, has made the construction of a telegraph system for this territory an imperative necessity. The recent creation of the new military Department of Alaska, with headquarters at St. Michael, on Norton Sound, and the establishment of military garrisons along the Yukon to the Canadian border, has made such a line a commercial and military necessity.

Congress recently authorized an expenditure of $450,000 for the construction of such a line, and at this moment all the material for the construction and equipment of this system is under contract, and the work of manufacture is being pushed night and day.

Owing to the shortness of the working season in this latitude, and the very unusual conditions under which the line must be constructed, as well as the lack of any adequate transportation, it will probably not be possible to complete the line this season.

The military cable connecting the gold district of Cape Nome with the headquarters at St. Michael, and also connecting St. Michael with Unalaklik, which is to be the terminus of the land line up the Yukon, will be completed early in September next, and will place the department commander at St. Michael in direct communication with Cape Nome.

These submarine cables, as well as all cables for the Philippine Islands, involving in the aggregate nearly 800 miles, are being constructed by American manufacturers, and are to be laid, equipped, and operated by American engineers.

The military forts to be connected, with the approximate distances, are shown in the following table:

	Valdez.	Fort Egbert.	Circle City.	Fort Yukon.	Rampart.	Fort Gibbon.	St. Michael.
Fort Egbert.......	350	....	....	....	....	....	....
Circle City........	520	170	....	....	....	....	....
Fort Yukon.......	610	260	90	....	....	....	....
Rampart..........	870	520	350	260	....	....	....
Fort Gibbon	940	590	420	330	70	....	....
St. Michael	1,490	1,140	970	880	620	550	....
Cape Nome	1,610	1,260	1,090	1,000	740	670	120

By a recent temporary arrangement with the Canadian authorities this telegraph system will be enabled to reach the United States over the line now being constructed by the Canadian government between Atlin and Quesnolle, a distance of about 900 miles. It is doubtful, however, if this land line can be completed this season. When completed, and in connection with the Alaskan system outlined above, there will be direct telegraphic communication between the United States and the military department of Alaska at St. Michael.

INTER-ISLAND COMMUNICATION FOR THE HAWAIIAN GROUP.

There is no other example in the world of a highly civilized community, with a republican form of government, which is entirely cut off from all communication from the rest of the world, except the Hawaiian Islands. A system of communication between the principal islands, either by submarine cable or by wireless telegraph method, is a necessity, and it is reported that this work, by the use of wireless telegraphy, is about to be carried out. The principal islands of the Hawaiian group which should be connected, with the approximate distances involved, are given in the following table:

	Distance, Naut. Miles.
Kauai to Oahu	61
Oahu to Molokai	23
Molokai to Maui	8
Maui to Hawaii	26
Total	118

TELEGRAPH SYSTEM IN CUBA AND PUERTO RICO.

The land telegraph system of Cuba now aggregates about 2500 miles and includes a central trunk line the entire length of the island, which is duplicated from Havana to Sancti Spiritus. In addition to this trunk line there are no less than thirteen lines across the island, which divide the island up into comparatively small sections. Although these lines have had to be entirely reconstructed under great difficulties, yet their reliability is evidenced by the fact that the entire Puerto Rican government business, which is now transmitted over the new land lines from Havana to Santiago, was conducted during the month of June without a single interruption.

In the island of Puerto Rico every important commercial or military point is in telegraph connection by a system of lines, which, under Major W. A. Glassford, Signal Corps, has been entirely reconstructed and routes improved since the disastrous hurricane of 1899.

A Pacific Cable.

In order to bind together the local land telegraph systems, which have been outlined above, these systems should be directly connected at an early date with the United States. First of all, in this colonial system, is the proposed trans-Pacific cable, connecting California with the Hawaiian Islands, thence to Midway Island, thence to the Island of Guam, and from thence to the Island of Luzon. The project of a trans-Pacific cable has been much discussed recently, and President McKinley sounded the key-note for its construction in his message to Congress in February, 1899, in which he states that "Such communication should be established in such a way as to be wholly under the control of the United States, whether in time of peace or of war." The construction of such a cable has been shown to be entirely practicable, and American manufacturers have shown themselves willing to undertake and guarantee the manufacture, laying, equipment, and operation of such a system of trans-Pacific cables.

Although deep-sea cable manufacture is an interest little known by experience in this country, yet it is believed that American capital and American skill and ingenuity, supplemented, if necessary, from abroad, can accomplish this great work in a comparatively short time. From every standpoint—commercial, strategic, and political—a trans-Pacific cable along the route mentioned should be undertaken at the earliest possible date. Next to the Isthmian Canal, no other great public work compares with it in importance to the future development of the United States.

The telegraph system of Alaska, now authorized and under construction, should also be connected to the United States by lines touching only American territory, and exclusively under American control. A cable system from Vancouver via the Aleutian Islands to Japan and the Philippines has long been proposed, and has many points, commercial and technical, in its favor as a trans-Pacific route. The true solution is thought to be the early construction of both of these trans-Pacific cable lines, thereby furnishing, first, a direct connection to the United States' Alaskan system, and by a later extension to the Philippines, a duplicate route for the protection of the more southern line via Hawaii, which should be first constructed. A short cable from Sitka to Valdez would be one means of perfecting a junction with the Alaska land system.

The recent acquisition by the United States of the Island of Tutuila, and the construction in Pango Pango harbor of a coaling station, makes it desirable to join this advanced American station in the southwestern Pacific to the Hawaiian Islands by submarine cable.

This can probably be most readily accomplished by connecting it directly to Fiji, a station on the British Pacific cable route.

To further complete this proposed colonial telegraph system, it will be necessary to connect the Island of Puerto Rico, by submarine cable, to the United States, and although of greater length, a line direct from New York to Puerto Rico is suggested as offering many advantages. The shortest line is not always the most advantageous. For instance, Hayti is connected direct to New York City, instead of to the coast of Florida, which would be much shorter, and Bermuda is connected direct with Halifax for the sole object of exclusive British control under all circumstances.

ESTIMATED COST OF PROPOSED COLONIAL TELEGRAPH SYSTEM.

CABLES IN THE PACIFIC.

Trans-Pacific cable, San Francisco, via Hawaiian Islands, Midway Island, and Island of Guam to Luzon	$12,000,000
Inter-Island communication for the Hawaiian Group.	150,000

To complete the Inter-Island telegraph system of the Philippines	250,000
For Alaska telegraph system, as already authorized by Congress	450,000
To extend the Alaska telegraph system, and to connect it to the United States by direct cable, and also for further extension to the Philippines, via the Aleutian Islands, providing a duplicate trans-Pacific route to the Philippines	10,000,000
For cable connections with Tutuila Island coaling station at Pango Pango harbor	650,000

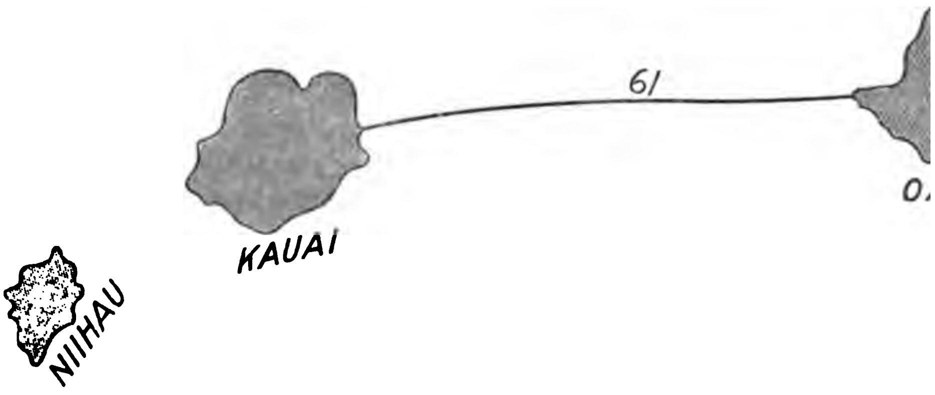
CABLES IN THE ATLANTIC.

Direct cable from the coast of the United States to the Island of Puerto Rico	1,500,000
Total	$25,000,000
Estimated cost of proposed Isthmian Canal	$140,000,000
Relative cost of two enterprises	1 to 5.6

The above estimate, which is necessarily a very general one, due to fluctuations in the price of materials, the inexperience of American manufacturers, etc., shows that with an expenditure of $25,000,000, or perhaps $30,000,000 at most, the United States can have a telegraph system connecting all her possessions, and placing each part of such possessions in direct connection with the United States by the best and most efficient means of communication known.

For the expense of three or four first-class battleships the United States can provide herself with the most powerful means known for extending and preserving her commercial influence, for the speedy pacification and civilization of the people who have recently come under her control, and secure a strategic advantage—military, naval, and political—which is necessary to the position of the United States as a world power.

It is believed that there is no measure which should receive more immediate and careful consideration than the establishment of a system of deep-sea cables, wholly under the control of the United States, and joining the already extensive land telegraph system of our new possessions.



PROPOSED INTER-ISLAND
COMMUNICATION
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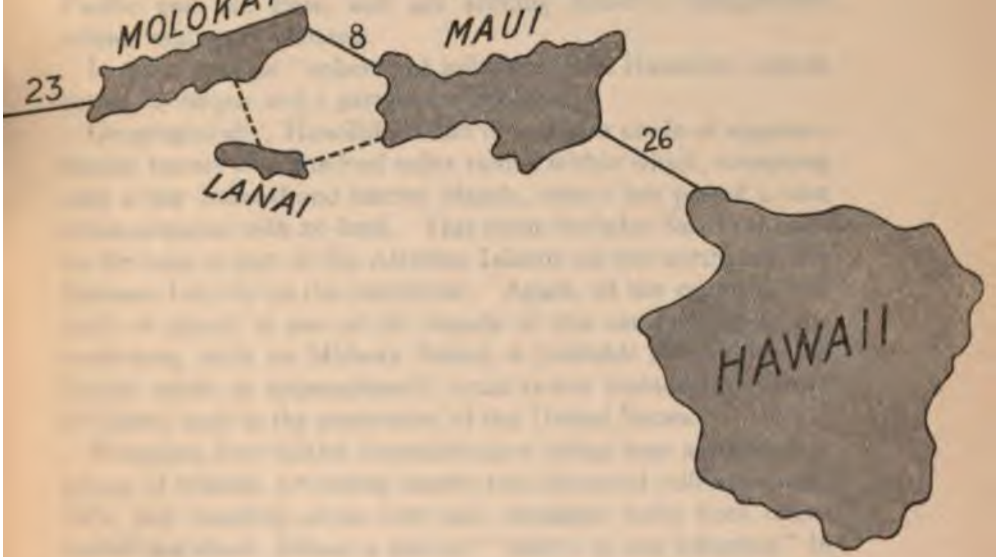

MOLOKAI
8
MAUI
23
26
LANAI
HAWAII

American commerce, American diplomacy, and American military and naval prestige, all conspire in demanding this system at the earliest possible date.

THE STRATEGIC VALUE OF THE PACIFIC CABLE.

The control of the seas along the great natural lines of national commerce is chief among the material elements which contribute to the power and prosperity of nations.

The possession of the Hawaiian Islands by the United States has a far greater future importance than mere import and export statistics can ever indicate.

The leading powers are evidencing unusual interest in the Pacific and the East, and are seeking hitherto unimportant islands wherever situated.

In these days of "spheres of influence" the Hawaiian Islands occupy a unique and a paramount position.

Geographically, Honolulu is the center of a circle of approximately twenty-one hundred miles radius within which, excepting only a few isolated and barren islands, nature has placed a vast ocean expanse with no land. This circle includes San Francisco on the east, a part of the Aleutian Islands on the north, and the Samoan Islands on the southwest. Again, of the center of the circle is placed at one of the islands of this same group to the northwest, such as Midway Island, a probable station for the Pacific cable, an approximately equal radius includes the Island of Guam, now in the possession of the United States.

Hawaiian inter-island communication being now assured, this group of islands, extending nearly two thousand miles in longitude, and standing alone over two thousand miles from continental mainland, defines a natural "sphere of sea influence" in the North Pacific of incalculable value to the future of the United States.

The importance of the geographical position of this group is only properly determined by reference to the changes in the great trade routes which will result from the Isthmian Canal. Whether ultimately at Nicaragua or Panama, the immense merchant fleet, which will pass through this gateway, will find the Hawaiian group upon its direct course to the East, and at such steaming distance as to naturally require this as a mid-ocean stopping place. Again, the British-Canadian commercial route to Australasia along which the British Pacific cable is projected, as well as the direct mail and trade route from the Pacific States to the Philippine Islands and the East, both naturally pass through these islands.

It can be stated that there is scarcely any point in the world where there is greater need for a central cable station than in the Hawaiian Islands. Geographically situated at the military and commercial strategic position of the North Pacific Ocean, it will ultimately serve as the distributing center for ocean communication between the two hemispheres as well as to the various island groups of the Pacific.

Although it is said that cables are primarily established for peace rather than for short periods of war, yet in these advanced American outposts, extending in a chain to the Philippines in the East, the demands of both peace and war happily coincide.

Submarine cables are now established for colonial, political, and diplomatic reasons, as really as for their purely commercial purposes. Nor is actual state of war of the country itself the only fear; witness the present plight of France due to the Transvaal war; owing to the fact that the cables to South Africa are under the control of England, and the establishment by her of a war censorship, France is absolutely dependent upon England not only for news from the Transvaal, but also for communication with her own colony of Madagascar and her South Africa possessions. The importance of this subject has led her Colonial Commission to recommend recently the immediate construction of submarine cables joining France with Senegal, Madagascar and Tonkin, the latter connecting with the Danish company's cables. Indeed, the plan ultimately involves an estimated expenditure of twenty-five million dollars and includes a complete colonial cable system.

By whatever method the first Pacific cable is ultimately laid, and provided that it shall appear that all of the present projected cable cannot be manufactured and laid in the United States within a reasonable time, it seems plain that the encouragement of American manufacturers in the building up in the United States of a deep-sea cable industry of the first class, is a wise policy for this government.

The successful completion of the submarine cable across the Pacific will mark an epoch in the telegraph history of the world.

After thirty years of consideration—technical, commercial and political—the end of the century sees this great enterprise at last seriously undertaken. The full influence which it will exert upon the Western Hemisphere and the world in general is not easily appreciated. Strategically the importance of the inter-colonial communication and its preservation are very great; however, the Philippine question should not overshadow the larger question—the Eastern question—in the consideration of this project. Important as the cable will be as a means of joining the Philippine Archipelago to the United States, its larger importance will ultimately be in the future commercial development between the United States and the far East. In the broad extension of Pacific trade consequent upon the completion of the Isthmian Canal, and the development of steamship lines plying the Pacific, the telegraph cable would naturally become an important factor. The present trans-Pacific steamship lines are heavily handicapped by absence of direct means of telegraphy between the ports between which they operate. Situated on the main trade routes leading from the canal to Asiatic ports, the Pacific cable will serve as a powerful adjunct and support to this enterprise. The two go hand in hand and are mutually closely related.

THE MILITARY CONTROL OF TELEGRAPH CABLES IN TIME OF WAR.

The International Convention for the protection of submarine cables, which met at Paris in 1884, made no provision defining the rights and immunities of cable property in time of war.

In addition to incorporating an article in the convention, stipulating that "this convention shall in nowise affect the liberty of belligerents," Lord Lyons, the British delegate, submitted the following declaration, at the moment of signing the convention: "Her Majesty's government understands Article XV in this sense, that in time of war, a belligerent, a signatory of the convention, shall be free to act in regard to submarine cables as if the convention did not exist."

M. Leopold Orban, in the name of the Belgian government, also submitted the following declaration:

"The Belgian government, through its delegates to the conference, has maintained that the convention has no effect upon the rights of belligerent powers; These rights would be neithe more or less extensive after the signature than they are now The mention inserted in Article XV, although absolutely useles in the opinion of the Belgian government, would not, however justify a refusal on its part to unite in a work the expediency o which is indisputable."

Before the Spanish-American war there were few examples o damages done to submarine cables by belligerents.

As has been pointed out, Article XV of the Convention o Paris, of 1884, for the protection of submarine cables, subscribe to by twenty-six nations, specifically states that "The stipulations of this convention shall in no wise affect the liberty o belligerents." In consequence, the question as to what, if any special protection was to be accorded submarine cables in tim of war, remained theoretical until the Spanish-American wa of 1898, when a practical rule of action as outlined by General A. W. Greely, Chief Signal Officer of the U. S. Army.

Upon the declaration of war, General Greely, upon whom by law devolved the operation of military telegraph lines and cables, was called into the national council for his opinion as to the line of action best calculated to subserve the legitimate rights of commerce and industry, while conserving the military interests o the United States. He took the view that, inasmuch as postal communications were forbidden between belligerents, prohibitive orders should issue against such telegraphic correspondence as might benefit the public enemy, pointing out that telegrams, by their secrecy and rapidity, produce military results much more important and injurious than is possible by the use of the mail.

First of all standing for a liberal policy consistent with our advanced civilization, it was advised that cable operations should continue over the international cables between Havana and Florida, of course, under strict military censorship. Military possession of the Key West telegraph office was taken on April 23, 1898, and the cables cut so that Jacksonville could no longe work with Havana. Domestic and business messages in ope text were allowed to be sent and received from Havana, bu only under strict military censorship. Similar action was take at Havana by the Governor-General of Cuba, who established rigid Spanish military censorship, so that all messages wer subject to double scrutiny.

Five classes of cables were recognized:

First. Those of which the termini are in the enemy's country; for instance, the Cuba Submarine Cable system along the south coast of Cuba.

Second. Which directly connect countries at war, so that each belligerent controls one end of cable; for instance, the International Oceanic Telegraph Company between Florida and Havana.

Third. Where one end of the cable is in the enemy's country and the other in neutral territory; for instance, the West India and Panama cables extending from Jamaica to Cuba, and to Puerto Rico, and thence to Saint Thomas.

Fourth. Where a cable extends from the coast of an offensive belligerent to a neutral country contiguous to the territory of the defensive belligerent; for instance, the Hayti cable from New York City to Hayti, where there is direct cable connection with the Island of Cuba.

Fifth. Other cables having one terminus in the territory of the offensive belligerent and the other in neutral regions remote from the scene of hostility; for instance, the Atlantic cables connecting the United States with Europe.

To cables of the first class, whether the property of the defending enemy or a neutral corporation, was applied the simple and well-known rule that they are subject to the vicissitudes of war, and that being in use for war purposes they are proper objects of offensive military operations. The orders issued to the officers of the Signal Corps looked upon these cables, whether they were laid in the high sea or along the immediate coast, as liable to seizure and total destruction.

Cables of the second class were easily dealt with, the cables between Key West and Havana were taken possession of militarily by Spain in Cuba and by the American army in Key West. Messages going and coming were subjected to the most rigid military censorship at both ends of the cable. Only messages in plain text bearing upon business and social subjects were permitted, and where any suspicion existed as to the loyalty of the sender, were either refused or not sent. Exceptional cipher messages were permitted as a matter of courtesy and favor to selected diplomatic representatives of neutral nations.

The cables of the third class were viewed as contraband of war; but it was also recognized that their liability to destruction depended in a measure on the locality of the cable. It was recognized as unsettled and of doubtful expediency, the right of any belligerent to raise from the bottom and destroy on the high sea a neutral cable, merely on the ground that such cable landed in a hostile country. A more rigid rule was applied, however, to such portions of cables, cable huts, instruments, etc., as were located within the territorial jurisdiction of the enemy. Orders were given, based on the principle that such cable properties, whether belonging to an enemy or to neutral corporations, are not only subject to the vicissitudes of war, but, being contraband of war, are legitimate objects of military operations.

In accordance with this view orders were issued to cut, off the south coast of Cuba, any cables that could be grappled and picked up, either within a marine league of the coast or within range of Spanish batteries.

In Cuba and Puerto Rico, during the Spanish-American war, certain neutral cable stations of this class fell within the power of the army of the United States. In such cases the officials of the neutral cable companies were given a choice of action. They could abandon their property to the vicissitudes of war, or accepting the *force-majoure,* were allowed to transact business under strict military censorship. Even during the siege of Santiago the orders permitted the French Telegraphic Cable Company to accept business for Santiago-de-Cuba within the Spanish lines, every such message, however, to be vised by the military censor.

The fourth class of cables was seized by the military forces of the United States and operated under strict military censorship. Code and cipher messages were absolutely refused save for the authorized government agents and certain excepted diplomatic representatives, the latter as a matter of courtesy.

Cables of the fifth class were placed under a military censorship. Of these, there were five systems comprising eleven separate cables. Most of these telegraph cables were only constructively seized, intrusting the direct censorship of messages, under the general supervision of an officer of the Signal Corps, to the respective superintendents, men of high character, whose good faith was guaranteed by the companies whose interests they likewise guarded. The interests of the United States were thus subserved while the privacy of the affairs of the companies was conserved. The responsible officials gave a written pledge to observe such rules as might be filed by the Chief Signal Officer with the companies. These rules prohibited all messages to and from Spain, and also certain other classes which were deemed prejudicial to the military interests of the United States. In cases of doubt messages of the latter character were examined and vised by the military censor.

The events of the Spanish-American war brought to attention the whole subject of the legal rights of cable property, and the control of the same under varying and complex conditions, in time of war. In the absence of definite international law upon the many points involved, the United States was forced to take the initiative and use this powerful military weapon for the benefit of the cause of the United States, while at the same time respecting and subserving the rights of neutrals with an equity and fairness, which has always characterized the actions of this government.

In the West Indies, as well as in the Philippines, the cable question was always a paramount one, and the United States finds herself now confronted with legal questions, growing out of actions necessary in time of war. Since submarine cables have become such a dominant influence in time of war, and since the cases which may naturally arise are often complex and involved, it is clear that a further international cable conference is a necessity of the near future, in which a more definite international understanding of methods of procedure in time of war may be agreed to. This international conference could properly consider other international cable matters, which the great advance in submarine telegraphy has made important. Among those may be mentioned the construction and authorization of a uniform international cable code for economical and efficient communication between different parts of the world in any of the principal languages now authorized by the international telegraph rules. Since next year will be the 50th anniversary of the first successful submarine cable, this would perhaps be a fitting time for the calling of such an international cable convention.

THE CABLE EQUIPMENT OF A FLEET.

It seems clear from the history of the Spanish-American war that provisions must be made for laying, picking up, cutting, and operating submarine cables in time of war. From the outbreak of this war every attention was given to the problem of isolating the Island of Cuba from Spain.

The special fitting out of the Adria with cable appliances, as well as spare cable, the work of the St. Louis in cutting cables, the operations of the Marblehead, Nashville, and Windom at Cienfuegos, and of the Wampatuck, are too well known to be repeated here. It will be more valuable to endeavor to draw the correct conclusion from these operations, and thereby make proper provision for the execution of similar operations in time of war.

It appears that the searching for deep-sea cables in the high seas in time of war, without an accurate chart of the location of the cables, is a difficult and very doubtful operation; also that submarine cables must in general be interrupted near their landing places, where their exact location can be determined with certainty. From the experience of the Spanish-American war, operations of this kind are extremely dangerous, as the cable landing will be protected and defended by the enemy.

Supply of spare cable and suitable instruments for working the same, must be available, with every naval fleet; in order to supply the necessary communications with the shore, in case of the landing of either a co-operating army, or of temporary forces from the ships. Cableships engaged in either laying, cutting, or repairing cable near the shore, must either be provided with their own means of defense, or else convoyed by warships.

The above facts make it clear that a new type of naval ship is to make its appearance as a necessary adjunct to every naval fleet. Just as the naval repair ship, such as the Vulcan, has been found necessary, so will the new cable cruiser be an essential part of the navy of the near future. It is not intended here to enter into the question of the proper design of such ships best adapted for the purpose, but it would seem that a specially designed cableship with comparatively large coal capacity and high speed, and an armament of the lighter cruiser class, making her capable of defending herself and protecting her small boat parties, would be general conditions for the naval cableship of the future. She must carry a moderate supply of spare cable and machinery for laying and picking up cable, as well as instruments for testing and operating a cable, and the necessary buoys suitable, if necessary, for buoying the cable and operating the ship as a floating cable station. It is unnecessary to state that her personnel must be specially trained in the highly technical duties required, and from actual practice in all the operations necessary, be made ready for the performance of their duties efficiently under the conditions of war.

Although these naval cable cruisers in time of peace could be profitably employed in maintaining and repairing both cables belonging exclusively to the government and those subsidized by the government, under suitable arrangements, yet, at the outbreak of war, they should be absolutely and exclusively under the control of the government. It may be said at present that no modern fleet is complete without a cableship especially adapted for cable operations in time of war.

In addition to special cable-ships it is desirable and necessary that every warship should be provided with certain simple cable appliances for raising and cutting cables, and should have at least one person aboard familiar with the practical and technical side of cable operations.

Since submarine cables are so important a factor in national defense, they should be protected both at their shore landings and on the high seas by military and naval force.

In this connection it would seem advisable in case of government cables, or in cables subsidized by the government, to keep the exact route of important cables a secret, and prevent the publication of maps for general distribution, showing the exact location of cables in the deep sea. The location of the shore ends, however, are certain to be known, and probably will be the points where the cable must be picked up and interrupted. This forces, therefore, adequate land and naval protection for the landing places of all important strategic cables.

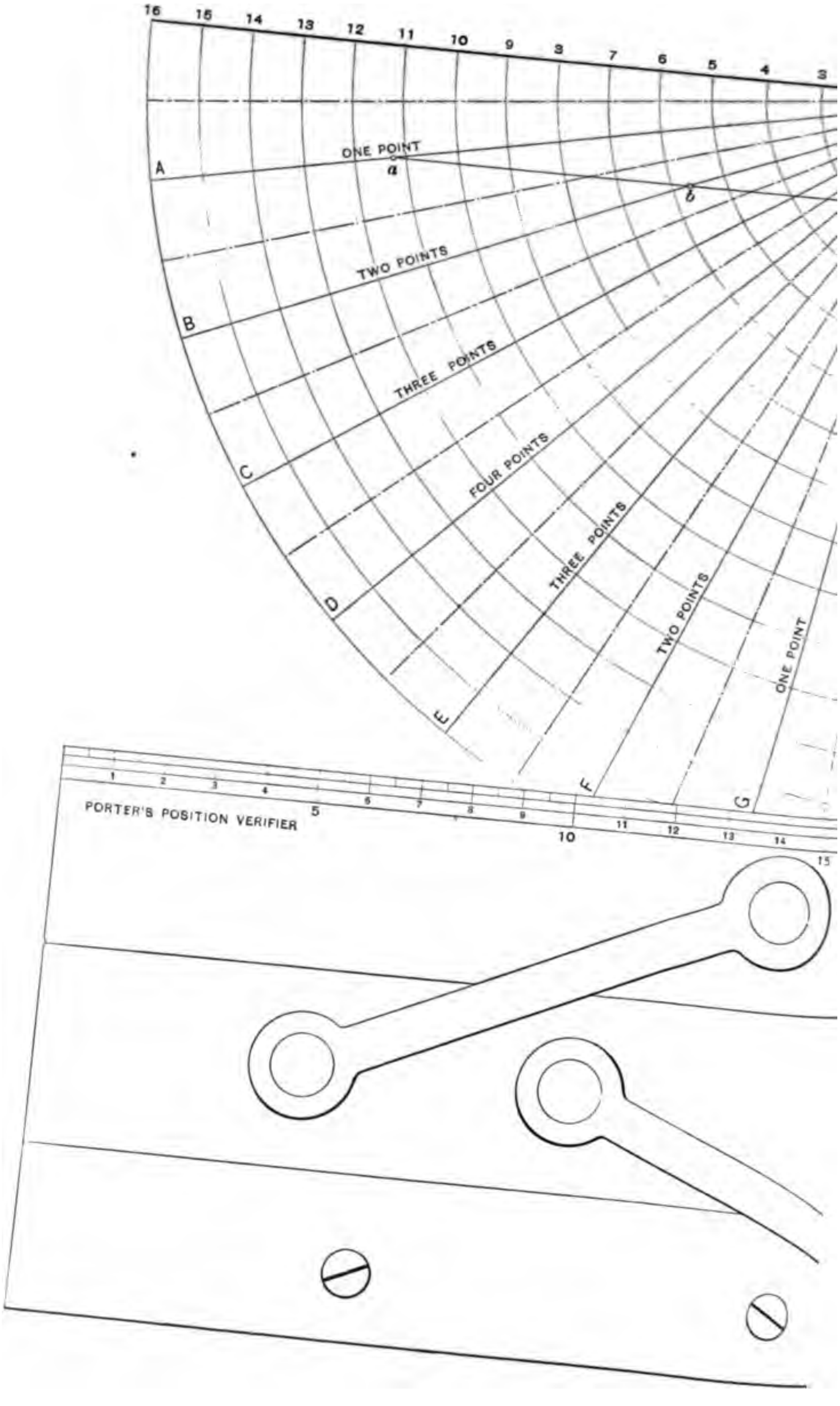
A cable landing of the future should partake of the character of a fort, and be provided with ample and adequate means for preventing an enemy locating and destroying the cable, within the marine league, or indeed, until it has reached deep-sea, where its accurate location is not known.

The sea is usually considered as the great international highway, belonging equally to all nations; this, however, is no longer true. The real political boundaries of states are no longer defined and restricted by the land, but involve such portions of the high seas as a nation can, by her commercial and naval vessels, and her submarine cables, reach out and secure. In this great sea division, which is so surely taking place, probably there are no better guides to boundaries than the submarine cable networks, which lie in its great depths. Since each, in general, uses the shortest path between two points, the general commercial sailing lines of the world are also the general direction of submarine cable lines.

The United States will be wise if, in the great Pacific, where she has such paramount natural advantages, both for commerce and for maritime strength, she pursues a broad, vigorous, and even lavish, " cable policy." We should be able at the earliest date to manufacture upon American soil deep-sea cables of the first class; be able to lay, maintain and repair them in time of peace or war, by ships flying the American flag, and be prepared to adequately protect them upon the high seas, and at their landing places, by military and naval force.

The cable question is one of the most important of the present hour, unique in that American commerce, diplomacy, and sea-power—in fact the most efficient means of advancing and securing the benefits of civilization itself—happily conspire in demanding its early solution.

[See maps at end of number.]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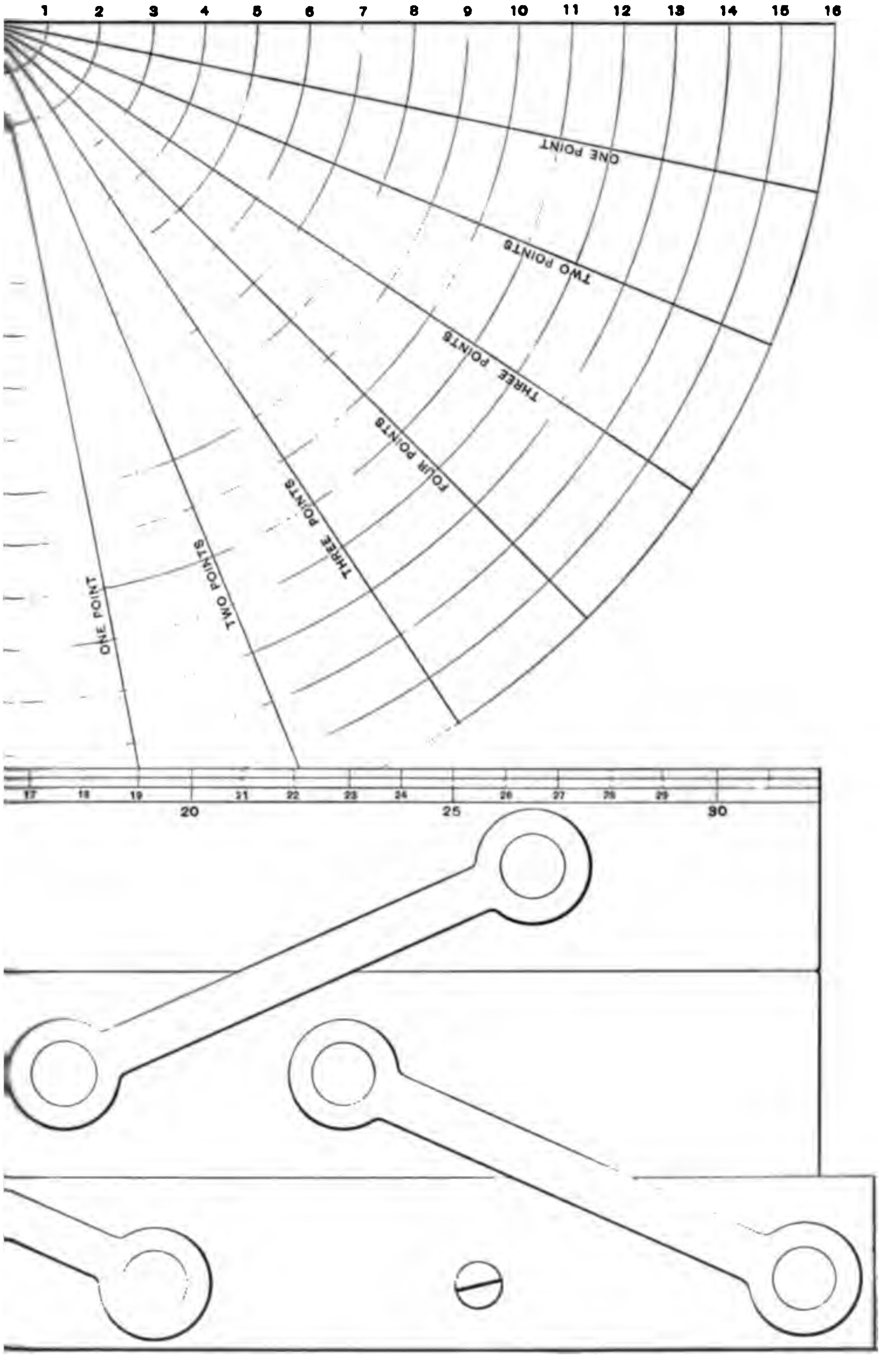
PORTER'S POSITION VERIFIER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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PORTER'S POSITION VERIFIER—AN AID TO SAFE COAST NAVIGATION.

By CAPTAIN ALLAN H. PORTER.

The instrument consists of a plane surface to which near the bottom is screwed the lowest of a system of triple parallel rules, the upper two having motion parallel to the horizontal diameter of the concentric semicircles drawn on the plane surface, and to which diameter the ship's course is supposed to be parallel. The upper edge of the uppermost rule and the horizontal diameter are graduated in the same scale of miles and parts.

The center of the concentric semicircles represents the objects upon which bearings are taken, and the semicircles are spaced one mile apart.

Radii are drawn at convenient angles from the horizontal diameter; in the sketch at the points and half-points.

The triple rules give facility and flexibility of motion, so that the distance run can be at once fitted between the appropriate radii.

The following example shows the use:

A lighthouse on the coast is observed to bear one point on the port bow. The ship holds her course and runs six miles, when the lighthouse bears two points on the port bow.

Move the parallel rules till the distance six miles on the upper rule is intercepted exactly between the one and two points radii, *AO* and *BO*. Then *a* and *b* represent the positions of the ship with respect to *O*, the lighthouse, at the times of observation. The ship was distant from the lighthouse 11.3 miles at the time of the first observation and is 5.7 miles away at the second; if she holds her course, she will pass the light abeam at a distance of

2.2 miles. The result can be verified by observing the di
run between the different lines of bearing and the ship's pc
assured before she is abreast of the object observed, whicl
the utmost consequence when there are outlying shoals.

This instrument supplies an automatic substitute for Tabl
and 5B of Bowditch, and instantly and graphically solv
problems coming thereunder.

Its simplicity and usefulness commend it to all who see i

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A STRETCHER FOR WOUNDED ON BOARD SHIP.

By LIEUT.-COMMANDER DENNIS H. MAHAN, U. S. Navy.

The stretcher consists of a board 6.5 feet long, 18 inches wide and 1¼ inches thick, with fittings as follows: Six rope handles, three on a side, for carrying purposes; a rope strap at each end for use with a whip or hook-rope when desiring either to lower down a hatchway or ease down a ladder; three canvas bands, one to pass across the breast, one across the abdomen, and one across the legs; and on the back two runners 1½ inches deep, useful when sliding down ladders. As experiment showed that the patient would slip, a buttock piece was inserted and with this and the abdomen strap the patient was absolutely secure and very comfortable.

The piece at the foot is merely a preventor, as the patient's feet should not touch it.

With a carpenter and a good seaman this stretcher can be made at any time on board ship; the cost being about one dollar.

During the spring of 1899 this stretcher was in use on the Brooklyn and also on other ships of the North Atlantic Squadron, and it was used during the Spanish war with great success.

DIMENSIONS.

(*a*) Stretcher bed,	length	6 feet 6 inches.
	breadth	1 foot 6 inches.
	thickness	1¼ inches.
(*b*) Buttock piece,	width of bed	
	height	3 inches.
	thickness	3 inches.
(*c*) Foot piece,	width of bed	
	height	3 inches.
	thickness	2 inches.

(*d*) Handles of rope.
(*e*) Straps fitted with thimbles.
(*f*) Chest bands, canvas, 3 inches wide.
(*g*) Abdomen bands, canvas, 4 inches wide.
(*h*) Leg bands, canvas, 3 inches wide.

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[illegible]	[illegible]	16⅝ inc
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[illegible] taken from a report of a

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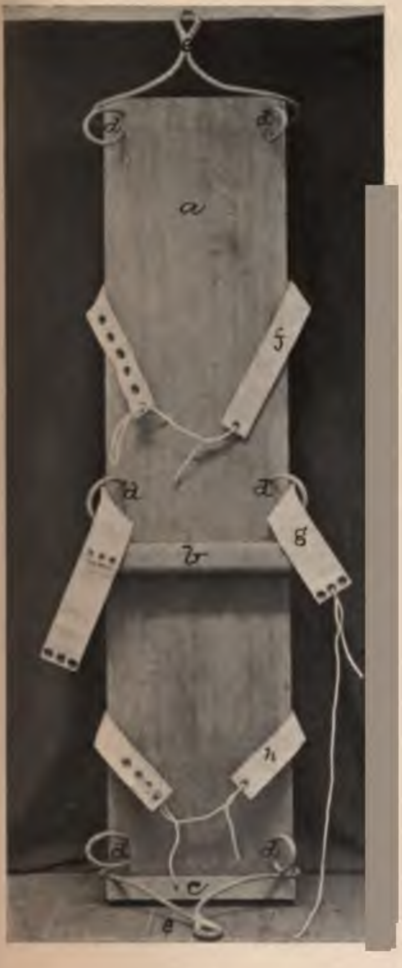

FIG. 1.

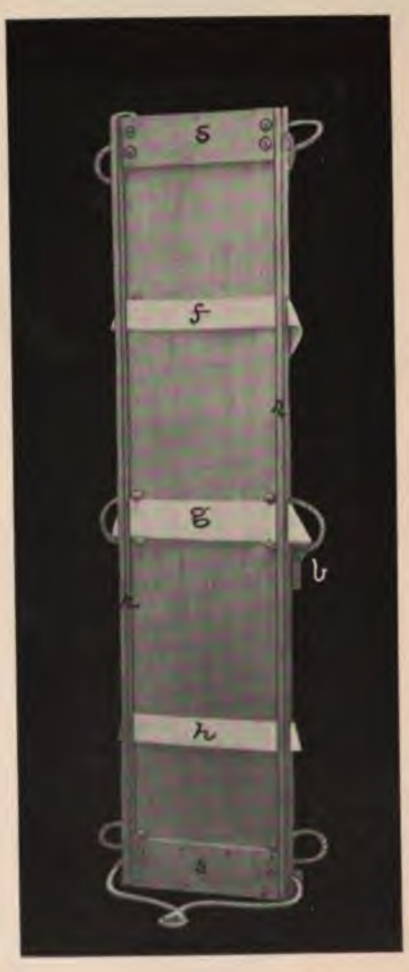

FIG. 2.

REAR VIEW.

(*r*) Runners,	length of bed	
	thickness	¾ inches.
	depth	1¾ inches.
(*s*) Strengthening pieces,	length	16¾ inches.
	width	5 inches.
	thickness	¾ inches.

The following extract is taken from a report of a Boar
Surgeons:

"The stretcher was fully tested by us, men of different hei
having been secured on it, and

"(*a*) Lowered in an upright position, feet first, from the r
to the berth deck, and

"(*b*) Brought back to the main deck in the same position.

"(*c*) After this the stretcher was turned in every way, with
man's head down, on the side, etc., and no slipping was notice

"The essential and original point of the stretcher is the cr
piece near the middle which comes just below the buttocks,
when the strap above is buckled, a man is held in a remark
secure and comfortable position. The other bands, one pas
around the arms and chest and the second around the legs
ordinary additional methods for adding to the security
retention.

"This stretcher is well adapted to all the ordinary purpose
transporting the wounded and is especially adapted for use
modern ships, where hatches are small and not in the same
If necessary it can be slid down ladders, or swung over the sl
side, with the wounded immovably and comfortably fixed.

"It can readily be made on board ship (if necessary) at a sı
cost. One has been in use on the U. S. S. Brooklyn for a
and has proved satisfactory in every particular. Another
been in use the same length of time on the U. S. S. Texas an
highly thought of by her medical officer. Other ships have i
use but we have no data from them.

"We recommend that the attention of the Surgeon-Genera
called to this stretcher and that it be adopted for use in all sl
of the navy."

Medical Inspector C. U. Gravatt, U. S. N., Fleet Surgeon
the North Atlantic Squadron, referred to this stretcher thus:

"Lieut-Commander Mahan designed a stretcher which p
sesses the valuable essential qualities of simplicity, ease of c

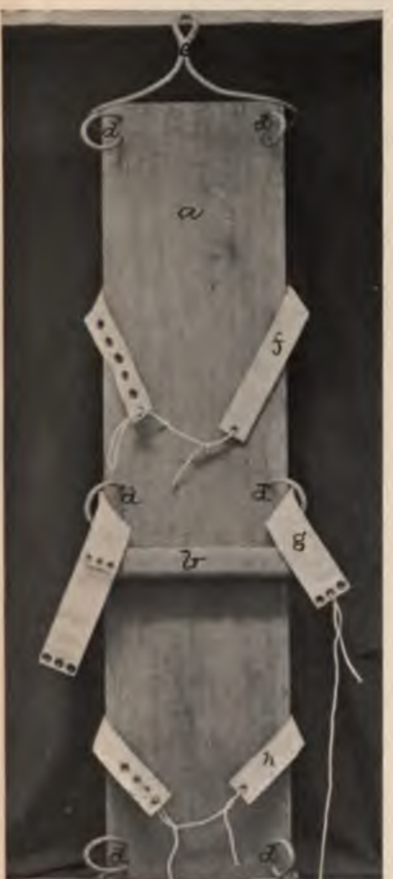

FIG. 1.

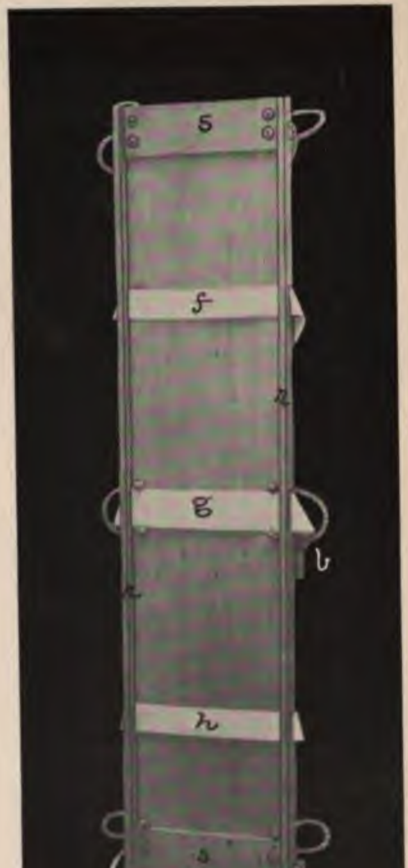

FIG. 2.

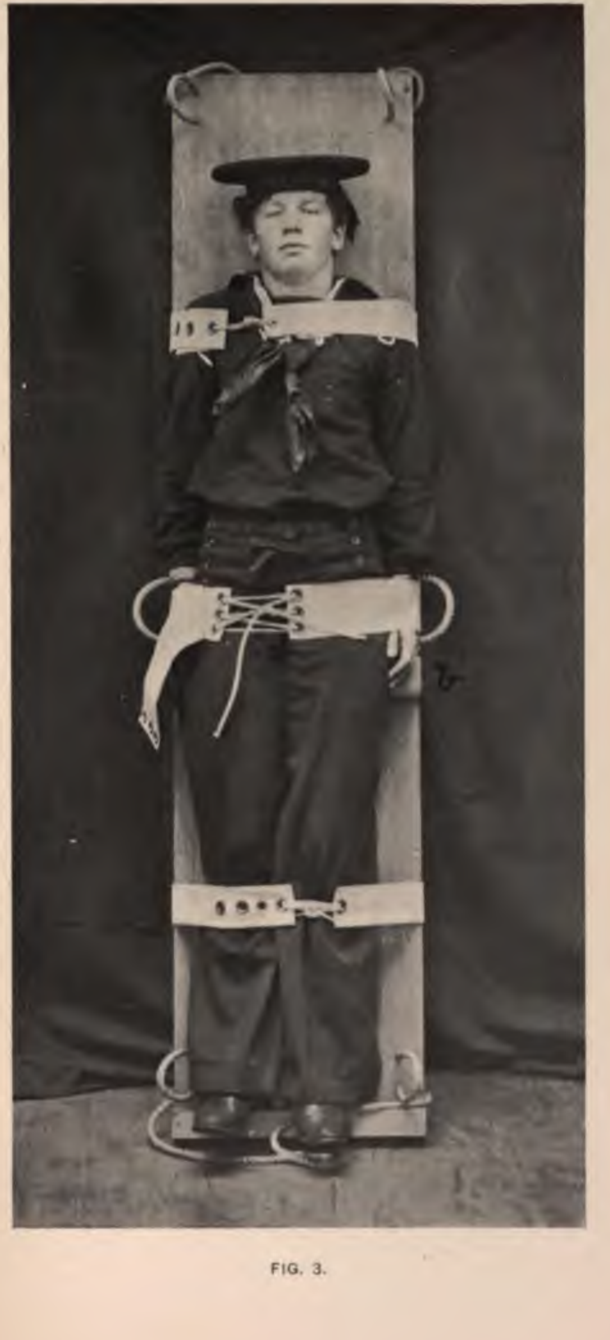

FIG. 3.

struction and efficiency, and which seems to surpass all others up to this time. As little more space is occupied than by a man's body, it can be readily accommodated in small boats. It was first thought the device could not be used for fractured thighs but in a severe case of this character it was most satisfactorily employed on the flagship New York last winter, and made transportation easy, which without it would have been difficult indeed. The writer was so well pleased with it on this occasion and others that during his service as fleet surgeon of the North Atlantic Station he advised its use on all the ships of the squadron, and, believing in its superior advantages, would be glad to see it adopted for general use in the navy."

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TORPEDO SAFETY DEVICES.

By Emil Gathmann, Ordnance Engineer.

Various writers of note have spoken disparagingly of the use of above-water torpedo on cruisers and the larger ships in general, considering them a greater danger to vessels carrying them than to her opponent.

Wet guncotton, which constitutes the charge for warheads of all modern torpedoes, is admittedly the safest of all known explosives (far safer than powder), for it cannot even be set on fire while wet. Projectiles of large caliber have repeatedly been fired into masses of wet guncotton (I have personally made and also witnessed many tests of this kind), without exploding or even igniting any of the latter.

It is not, then, the fear of any danger inherent to the main charge of explosive in torpedo that has led to outspoken statements of commanding officers, and in some instances to request to have above-water torpedo tubes removed from vessels under their command.

It must be admitted that the danger referred to and feared lies principally in the very sensitive nature of the primer and detonator necessarily employed in connection with a large mass of wet guncotton. The air-flask, or chamber, of torpedo charged to hundreds of pounds pressure per square inch with compressed air constitutes the remaining element of danger to the users of torpedoes.

The impact of even very small caliber projectiles with either detonator or air-flask of torpedo as now constructed would most likely cause detonation of main charge of wet guncotton in warhead and consequent disaster to ships carrying torpedoes.

The invention and development of the submerged tube and the tendency to its use, is proof of the realization by various nations of the real danger of above-water discharge with the usual type of torpedo.

How to at least greatly modify, in fact, to practically obviate these dangers, it will be the object of my paper to briefly explain.

First, I would state that I am a firm believer in the above-water torpedo. Not only will its efficiency and reliability as a weapon always remain greater; but the very safety the submerged tubes are vaunted to give can be obtained by the above-water torpedo to a far greater extent, and that at a small percentage of the cost of the former. My "ideal" type of torpedo for coast defense and the heavier vessels is the true aerial torpedo or large caliber high-explosive shell; but I will not enter into any detail description or extollation of same in this article, as I wish to confine myself strictly to the water or fish torpedo.

It has long been well known (although personally the fact was rediscovered from original experiments) that very close contact between detonator, primer and wet guncotton charge are essential in order to detonate the latter. This being the case, it occurred to me that it would be of great value to determine at least approximately at what point with a given protection of metallic diaphragm or barrier, absolute immunity against transmission of detonation from primer to main wet charge of guncotton would be insured. With this object in view, I undertook an extensive series of experiments on the transmission of detonation in steel tubes, with and without interposing barriers, which were mainly conducted at both the army and navy proving grounds, through the courtesy of the departments.

My first tests were made with a number of steel tubes of 2¾ inches inside diameter, of about 2 feet length. One-half the length of tubes were loaded with 20 ounces of wet guncotton, containing 25 per cent moisture. Metallic diaphragms or barriers of varying thicknesses were inserted in tubes, and primers of ten ounces of dry guncotton and 38 grains of fulminate of mercury were placed in other half of the tubes, being separated from the wet charge by interposing metallic barriers. Detonation of primers was then obtained by means of electric firing of fulminate detonators, in which a platinum bridge wrapped with wisps of dry guncotton had been secured. In order to insure recovery of fragments, and also to enable the determining of character of explosion, the loaded tubes were always placed in the proving ground shell explosion chambers. Some forty experiments of this character were made, with varying thicknesses of metallic barriers interposing between wet charges and primers. The same weight of wet charge containing 25 per cent of moisture and of primers and detonators were always employed. Three-eighths of an inch of mild steel as a barrier was found sufficient to effectually intercept the transmission of detonation. The greater part of tubes holding charges was invariably totally destroyed and broken up into many minute pieces, as were usually the interposing barriers. The wet compressed guncotton was always merely broken up and scattered about explosion chamber. Upon gathering up the wet guncotton, 97 to 99 per cent at least was always recovered, this being proof positive of the non-transmission of detonation when a suitable metallic barrier is interposed between priming and wet charge of guncotton.

It was also deemed of importance to learn to what extent detonation through the air, without interposing metallic barriers, could be carried, so as to be able to fully determine the value of said metallic barriers. Tests were accordingly made with similar steel tubes, only somewhat longer, with the barriers left out. An intervening air space of even as much as 14 inches failed to offer any protection. Detonation was repeatedly transmitted from primers of dry guncotton to the wet guncotton in tubes at this distance. In no instance were particles of guncotton found in explosion chamber, as had been the case when separating barriers were used.

The theory of protection offered by metallic separating barriers to transmission of detonation having thus been established, it remained to put the knowledge gained to some practical use. The safety fuse for high-explosive shell or aerial torpedoes, and the safety primer or detonator for fish torpedoes, the joint inventions of Mr. Louis Gathmann (my father) and of the writer, were the first practical uses to which these experiments have led. Numerous tests were then made with shells and torpedoes fitted with detonators having metallic barriers normally separating the main charge of wet guncotton from detonators and primers. Mechanical devices were invented and perfected which insured the interposition of barrier and isolation of detonator and primer from main charge until torpedo had been launched from tube and traveled a predetermined distance. A number of bronze torpedo heads, holding 85 pounds of wet guncotton, 25 per cent moisture, were built to be used experimentally in connection with the separating barriers.

Two of these shells or torpedo heads, loaded with 81 and 86 pounds of wet guncotton respectively, and having primers of 12 ounces of dry guncotton and detonators of 38 grains of fulminate of mercury, separated from the main charge by steel barriers one inch thick, were set up in a firing butt as targets for Hotchkiss 6-pounder guns. The rapid-fire gun was trained so as to deliver its shot directly in center of detonator and primer, and in line with the longer axis of torpedo. Distance of gun from torpedo about 75 feet. On firing of gun two distinct reports were heard, and upon returning to the butt and examining torpedo, it was seen that impact had been as desired upon center of primer housing. The detonation of priming charge of 12 ounces of guncotton and consequent rupturing of torpedo casing was seen to have been the only result. As was expected, in view of experiments which had already been made, the main charge of wet guncotton had been protected by the interposing metallic barrier, and was simply somewhat scattered about by the detonation of primer and impact of six-pounder. This test was repeated in the presence of Commander Mason, U. S. N., several U. S. Senators and other gentlemen of note, with the second target shell. Practically identical results were obtained in this test, it having been proven thereby that positive safety is obtained by the interposing barrier under all conditions. A similar torpedo head, loaded with 79 pounds of wet guncotton, with the metallic barrier removed (as would be the case after being launched from the tube and traveling some distance from ship's side) and primer in contact with main charge, was then detonated by means of electric fuse. A conical excavation some ten feet deep and eighteen feet diameter showed violence and excellence of the detonation when primer was in position for action.

By the normal isolation and separation of detonator from main charge and the arrangement of mechanism to bring same into close contact when desired, the first or principal danger and consequent objection to the over-water torpedo has been removed. Lieut. G. E. Armstrong, late R. N., in "Torpedo and Torpedo

Vessels," quotes from Mr. Arnold Foster, " In a Conning Tower," how the enemy is made to lose the battle through the confusion caused on board of her by the explosion of one of her torpedoes in its tube before it is launched.

Such premature explosion I can state (without fear of contradiction) would be altogether impossible were the normally separated primer for torpedo employed. Any of our torpedoes can be fitted therewith at a very slight expense, as the same pistol and nose pieces as are now employed could be used, thus precluding any exhaustive tests for regulating of new devices, etc. Detailed drawings submitted show how I would recommend to have changes made on warheads of torpedoes. The arrangement for bringing primer in close contact with main charge is entirely automatic and can only work after the torpedo has left its tube and traveled a predetermined distance in water from side of ship. Having thus shown how the first or greatest danger of the overwater torpedo can be obviated, I would beg leave to proceed to the second, and, in my opinion, only slightly lesser danger which arises from the likelihood of rupture of air-flask or chamber of torpedo should the same be struck by an enemy's missile. These air-flasks are, from the very nature of their construction, exceedingly fragile and cannot very well be made otherwise. Some tests made at Newport in the immediate past have shown that on impact of even very small-caliber projectiles the air-flask will burst explosively. Such explosion, although not necessarily imperiling the ship carrying torpedo, would still produce considerable damage by virtue of energy of flying pieces of flask, and certainly create considerable confusion aboard ship on which it took place. The accidental explosion of air-flask due to the enemy's missile or to other unforeseen causes we will always be at a loss to control. I would merely show a method whereby the damage resulting from such explosion would be reduced to a minimum. The danger due to explosion of flasks is mainly attributable to the scattering of pieces of same and their consequent projection and damage to surrounding objects and the torpedo crew.

As the air-flask of torpedo would doubtless be always charged in action, even though the torpedo were not entered into tube, I would propose that the torpedo be kept in a sling or cage, composed of a number of strong steel rings or wire grommets held together by two or more longitudinal stiffening rods. The rings or grommets should be spaced at intervals of, say, five or si inches, and particular care taken that portion of torpedo composed of air-flask or chamber is covered by same. Should th air-flask explode from any cause while in a sling of this description, the resulting damage could not be very great. The air i flask would simply press the shattered portions of shell agains the series of rings or grommets, which would prevent said piece from acquiring any velocity, and, consequently, from doing serious damage. The weight of such slings would not greatly excee that of the usual cages in which torpedoes are housed aboar ships. The slings would not be such in name only, but woul be used to transport the torpedo from its housing to its tube After the torpedo has been entered into tube and sling is empty it could be disassembled and knocked down, so as to occup but a very small space, especially if wire grommets were used as suggested.

The torpedo-tubes should also be covered at short intervals with strong wire grommets for confining pieces in case of explosion of flask while torpedo is in tube. Such wire grommets would not add over two per cent to the weight of tubes and torpedoes and would undoubtedly confine most of the fragments in case of disaster to air-flasks. I would state that both the grommets for slings and on torpedo-tubes should not be tight fitting, but should have sufficient clearance so as to only take up the strain of fragments incident after actual rupture of air-flasks or torpedo-tubes. This arrangement will allow the compressed air large vents for escape, but will retain most all the fragments of ruptured torpedo-flask and tube.

Exactly what degree of protection will be provided by torpedo sling and tube grommets as I have described, it is as yet impossible to state. Experiments are, however, being made by the writer to determine the proportion of fragments which will be retained by wire grommet slings fitted over the body of an old 18-inch air-flask.

It follows that with the simple changes in construction of detonator and the easily installed sling, appliances, described, the usual above-water torpedo, which has hitherto been considered a grave menace to its users, can readily be transformed into a weapon which is capable of always being handled with perfect safety.

This being granted (for I challenge proof to the contrary), there are no valid reasons why the relatively simple above-water tube torpedo should not be preferred to the complex, costly submerged tubes and apparatus.

The positive knowledge of officers and crew of torpedo vessels that they have nothing to fear from the forces they put into action, but that they are merely subject to ordinary chances of battle, will, to say the least, tend much to their morale and steadiness and consequent efficiency of their weapon.

Safety of weapon to the user should be the first essential in all military appliances and armament.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

OPERATIONS IN NORTH CHINA.

By Lieutenant W. C. Davidson, U. S. Navy.

Early in 1900, after the war in the Philippines had developed into a series of assassinations and guerrilla combats against our soldiers, the attention of the United States and the rest of the civilized world was called to a change of affairs in China which required foreign intervention for the protection of the lives and property of all classes of foreigners residing within the limits of the Chinese Empire.

An organization known as "Boxers" conceived the idea of exterminating all "foreign devils" in China and began operations by murdering the missionaries and other foreigners in the interior. The "Boxers" were originally an athletic society which, among other ceremonies, worshipped an immense sword or knife, and became known first, as the Great Sword Society, and later as the Society of the Avenging Sword. The Chinese characters have been variously translated to mean, not only the above, but also, the Righteous Arm Society, and this, by a still more liberal interpretation, was converted into the present name "Boxer." The organization has existed for nearly a hundred years, but until the introduction of railroads, foreign improvements, and the presence of missionaries in the interior of the country, it has given no trouble. With the presence and continued advance of foreigners, however, the ruling class of Chinese lost power over the common people, and consequently the Boxers are said to have been instigated by the Empress Dowager, together with some of the Princes and Viceroys, to exterminate all Europeans and Christian Chinese, thus hoping to return the country to its former state of exclusion and solitude.

In March, 1900, the situation began to look serious. The Boxers appeared in uniform in great numbers, armed with knives and spears, their distinguishing marks being red belts and red trimmings on their weapons. They first threatened the outlying missions along the line of the new railroad to Hankow, and later the Christian Chinese in and around Peking itself. The Chinese government took no notice of the movement and maintained that there was nothing to be feared from the Boxers, although evidence has since been found showing beyond all doubt the complicity of the Empress Dowager and others, and also showing that a general uprising had been planned to take place in September of this year.

The foreign ministers became alarmed, despite the protestations of the Chinese government, and in May asked for guards to protect the legations. Marines and bluejackets were sent up by the navies present at Taku until a force of about 600 armed foreigners were in Peking protecting lives and property. Early in June, the railroad communication between Tientsin and Peking was destroyed and actual hostilities began in the streets of the capital.

In the meantime a large fleet of war vessels of the various nations had assembled off Taku, and as soon as the news of hostilities was received, Vice-Admiral Seymour, R. N., with an allied force of about 2000 men, started towards Peking for the relief of the foreign ministers. This force was transported to Tientsin by rail and from there it proceeded on foot, the railroad above Tientsin being repaired as the troops advanced and used for the transportation of provisions.

Later, on the 14th of June, a force of about 800 allied troops, which had been landed at Tongku, were peremptorily ordered to return to their ships by the Chinese general commanding the Taku forts at the mouth of the Pei Ho. At this, the foreign naval commanders held a conference at which, the American admiral dissenting, it was decided to take possession of the forts in order to avoid further trouble with them, and an ultimatum was accordingly sent to the Chinese general on the 15th, demanding that he evacuate the forts before 2 A. M. of the following day.

Lying in the river at this time were the British ships Algerine, Whiting and Fame; the Russian ships Mandjur, Giliak and Koreetz; the French gunboat Lion; a Japanese gunboat; the

German ships Iltis and Jaguar; and the U. S. S. Monocacy, the latter having orders not to take part in the attack unless *directly* fired upon, and having besides another reason for not taking part, in that she had on board a large number of women and children refugees who could not be disposed of otherwise. Consequently, the foreign force available for the reduction of the forts consisted of the other gunboats named and the 800 British, Japanese and Russian soldiers and sailors at Tongku. The large fleet outside was nine miles away and hence took no part in the fight.

The Chinese forts, three in number, were all well-built mud forts with high walls and a large number of modern breech-loading rifles and rapid-fire guns mounted in barbette behind shields, the largest caliber being 8 inches. There were about 2000 well-armed imperial troops defending the forts and four new torpedo destroyers in the river at the Imperial Dock Yard a short distance above the forts. With this force at his command, the Chinese general did not choose to evacuate, but instead, at 1.30 A. M., on June 16, opened fire on the foreign ships in the river, some of which were anchored at Tongku, two miles above. These, with the exception of the Monocacy, got under way, dropped down the river and returned the fire until daylight, by which time several of the ships had been struck repeatedly, the advantage being clearly with the Chinese.

At daylight the troops on shore advanced, the Japanese and British on the north side and the Russians on the south side of the river, while the ships moved in between the forts and bombarded them at very short range. The British and Japanese troops assaulted the north fort, but were repulsed with considerable loss. They were quickly re-formed and advanced again, the rapid-fire guns of the ships keeping the Chinese behind their walls, when, just as the attacking force reached the wall the second time, a shell from the Algerine exploded the Chinese magazine, which was in an unprotected position above the wall. This so demoralized the Chinese that the attacking force was allowed to scale the walls and, after a short fight, to obtain possession of the fort.

On the south side of the river the Russians were equally successful, and the Chinese were driven out of all their forts. The Chinese lost heavily in killed and wounded. The foreign loss was 70 killed and wounded.

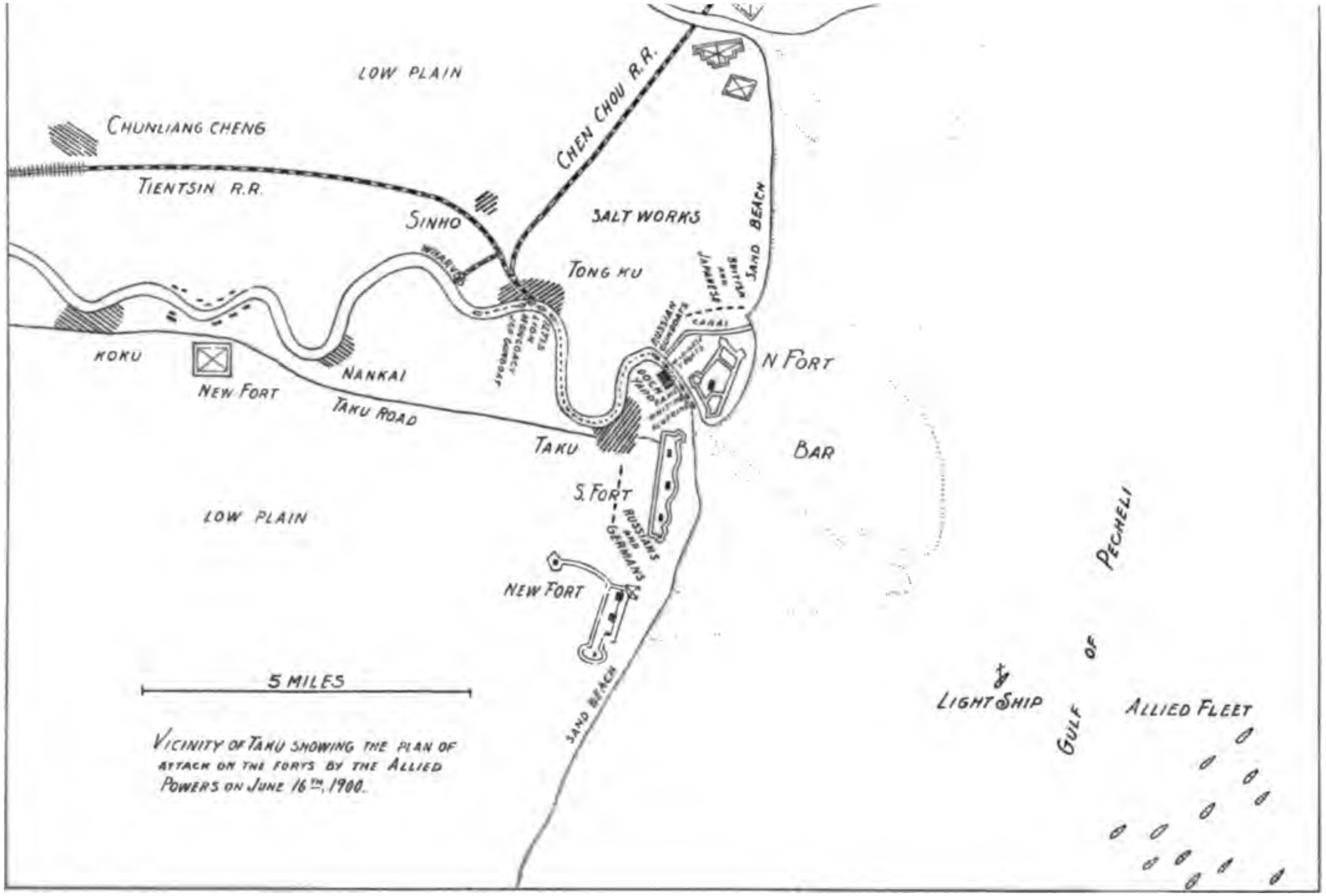
The four destroyers in the river were abandoned by the Chines crews, taken possession of by the British, and placed under th care of the Monocacy until later, when they were disposed of b giving one to the Russians, one to the French, one to the Germans, while the remaining one was retained by the English These boats afterwards did excellent service as despatch boat between Tongku and the fleet outside the bar.

The damage to the foreign fleet engaged was as follows:

The Russian gunboat Giliak was sunk by a shell exploding i her magazine, but as the water was shallow, she was afterward raised and repaired; the Iltis was badly damaged above the ra and had her executive officer and several men killed and her captain badly wounded; the Whiting received a shell in a col boiler; and the Monocacy, lying at Tongku, was struck by 6-inch shell which shattered a boat on her starboard side and the passed down and out through the port bow. A number of oth shells came near her, and, on account of the refugees on boar she was moved farther up the river out of the line of fire of th north fort on the ships coming down the river, many of th Chinese shells going high and falling in and about Tongku.

The damage to the forts was slight except for the destructi of the magazine in the north fort, and but for the assault of t landing party they could not have been taken. On the advan of the troops to the assault, the ships were from 400 to 10 yards distant from the forts, and at these ranges were able drive the Chinese from the walls and even from the guns wi shields by means of their rapid-fire and machine-guns.

The imperial troops were dispersed in the direction of t Peitang forts and Tientsin, followed by the Russian troops. line of Cossack posts was established along the railroad betwe Tongku and Tientsin and the road put in operation from t former place to where it had been torn up by the Chinese, miles out. By the mutual agreement of the foreign naval co manders, Commander F. M. Wise, U. S. N., commanding t U. S. S. Monocacy, was placed in charge of the railroad, buil ings, rolling stock and wharves at Tongku, all of which were be employed to the best advantage of all the powers. A rep sentative of each of the foreign naval powers was stationed Tongku, each to look after the interests of his own governm in regard to railroad transportation and landing facilities, s



VICINITY OF TAKU SHOWING THE PLAN OF ATTACK ON THE FORTS BY THE ALLIED POWERS ON JUNE 16TH, 1900.

ject to the approval of the commandant in charge. The fine tugs and lighters of the Taku Tug and Lighter Company were all commanded and used for landing troops, which soon began to arrive in large numbers, the disembarkation of which was no small matter under the circumstances of the location and also of the weather.

Up to this time Admiral Seymour had been advancing slowly towards Peking against the opposition of the Boxers, but now the imperial troops joined the Boxers and the relief force was compelled to turn back in the hope of reaching Tientsin. At Sikoo, a few miles above Tientsin, the care of the wounded and the scarcity of ammunition caused the relief force to halt and capture the arsenal there, where they found large supplies of new Mannelicher rifles and ammunition, with which they armed themselves and so were enabled to hold out until the arrival of the second relief force on the 21st of June, when the place was abandoned and the allies returned to Tientsin. The American loss in this expedition was 4 killed and 27 wounded.

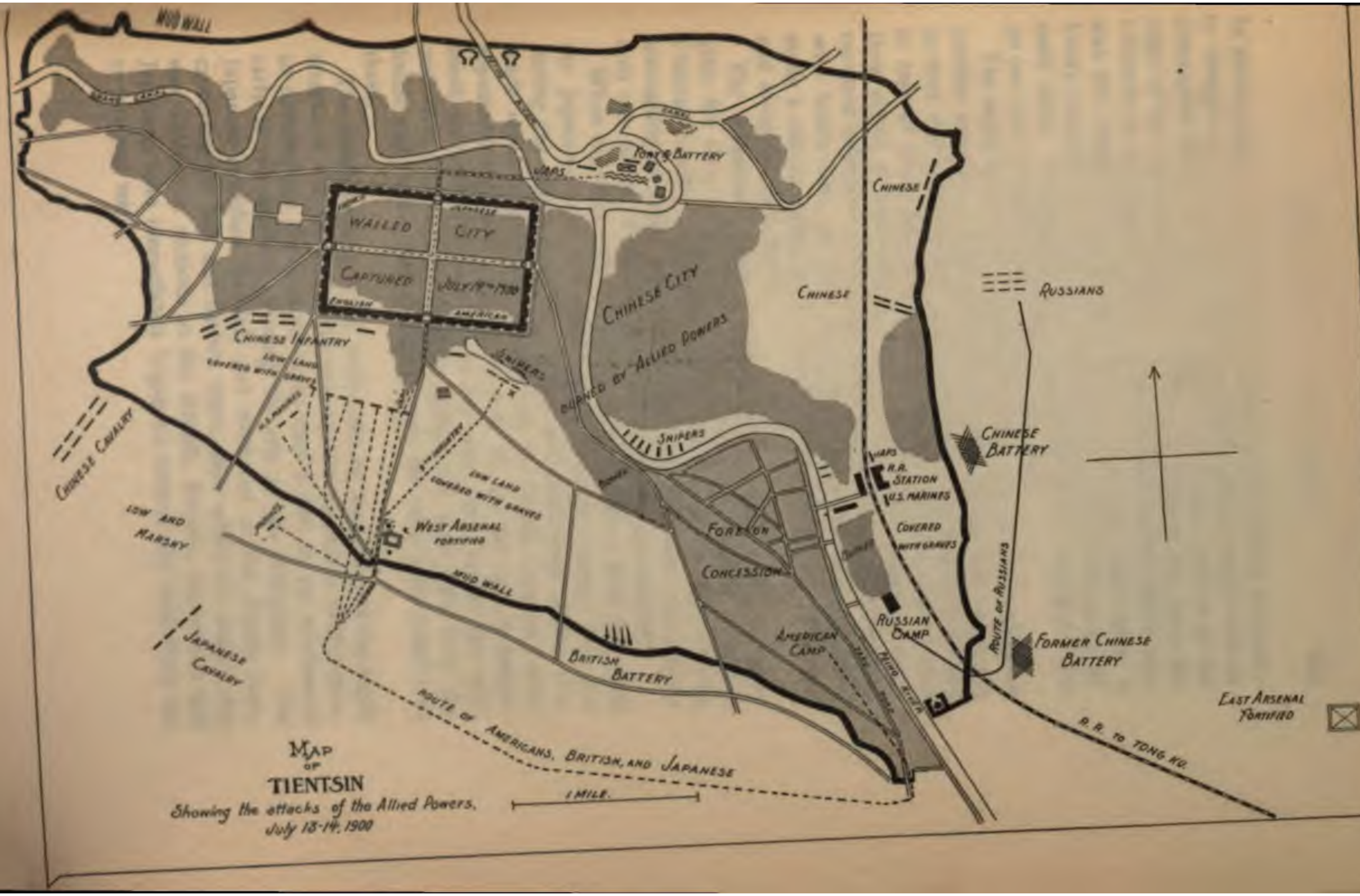
In the meantime the Chinese had taken the offensive at Tientsin and were attempting to destroy the foreign concession. A portion of the railway to Tongku had already been destroyed and the Chinese had endeavored to capture the railway station which was the key to the whole situation. There were now in Tientsin about 8000 foreign troops, but they were practically without artillery, while the Chinese were well supplied with all kinds of guns and ammunition and were bombarding the concession from three sides day and night. They carried on most of their operations from the East and the West Arsenals and from a battery outside the east Mud Wall. There were also a fort and battery north of the concession and a number of guns on the walls of the old city. The fire from the arsenals became so annoying that Major Waller, U. S. M. C., with 130 marines, a detachment of the Welsh Fusileers and some Japanese troops, went against them and captured them by bayonet charges and destroyed the batteries.

Reenforcements with artillery began to arrive early in July, some of the British guns throwing lyddite shells, and the foreigners again began to assume the offensive. A battalion of U. S. marines was landed on the 9th, one company of which was immediately sent to reenforce the railroad station which was then guarded by the Sikhs, the Wei hai wei Chinese regiment two companies of French, and a detachment of Russian troops. A few days later the Chinese made a determined effort to drive out this force and obtain possession of the station. Hand-to-hand fighting took place, whereupon the French troops withdrew across the river, delaying somewhat the advance across the pontoon bridge of a battalion of Japanese troops that were coming as reenforcements. Upon the arrival of the Japanese troops, however, the Chinese were driven back, but they continued to bombard the place until the walls of the engine house were almost shot away and the defenders had to take shelter in the engine pits and cover themselves with railroad ties to avoid the flying bricks. The Wei hai wei Chinese regiment in the service of the British did excellent work in this fight, thus showing the possibilities of the Chinese soldier when properly led.

The 9th U. S. Infantry arrived in Tientsin on the 11th of July, and on the 12th a regiment of Russian artillery was sent up, bringing the number of foreign troops up to about 14,000 men. so that it was decided to attack the walled city on the 13th. The Russians were to capture the batteries along the east Mud Wal and then take the fort and battery north of the concession, whil the British, Americans and Japanese were to advance on th south wall of the old city and force an entrance through th South Gate. The success of the latter movement depended upo the efforts of the Japanese to blow up the gate with dynamite.

Early in the morning the allies made their attack. The Russians succeeded in clearing the Chinese away from the eas Mud Wall but met with such opposition that they could not ge inside the wall to attack the fort and battery to the northward The other foreign troops went over and through the south Mu Wall at the West Arsenal and advanced towards the walled cit under a terrible fire until forced to take shelter behind grave and other obstructions.

The American marines were on the extreme left, with th British next, and then the Japanese, while it was intended for th 9th Infantry to take the right of the line. Owing to a broke bridge and a lack of knowledge of the ground, the 9th becam detached from the main body and advanced alone as far as diagonal road leading to the South Gate. Here they met wit both a front and a flank fire which made their position untenabl



MAP
OF
TIENTSIN
Showing the attacks of the Allied Powers,
July 13-14, 1900

In attempting to drive out the flanking force it became necessary to charge across a level piece of ground behind which was an impassable body of water, and when our troops arrived at the edge of the water they were met by a murderous fire from the Chinese on the opposite side. General Liscum was killed here and the troops forced to lie down in mud and water under a heavy cross-fire at short range and remain there from 9 A. M. until dark. Fortunately only one battalion was engaged, over 20 per cent of which were killed or wounded.

The main body fared somewhat better, but even they suffered terribly and were compelled to take what shelter they could get in mud and water, behind graves, while the ground in front and in rear of them was kept torn up by the Chinese fire, so that they could neither advance nor retire. The Japanese made repeated attempts to force the gate, but were each time repulsed with heavy loss, so that when dark came the battered allies made a run for safety behind the Mud Wall, carrying their dead and wounded with them.

The foreigners were actually defeated, and with an energetic foe they would have been annihilated. A heavy force of Chinese cavalry remained off the left flank all day without attempting to make any attack, although they were opposed by only two troops of Japanese cavalry and 50 of our marines.

When the allies had re-formed behind the Mud Wall after dark the Japanese were the only troops with any energy left, and during the night, while the British and Americans rested, they made repeated attempts to blow up the South Gate and were repeatedly repulsed. Finally, at 2 A. M., on the 14th, a detachment succeeded in blowing up the outer gate, scaled the wall, and after a hand-to-hand fight, opened the inner gate from the inside and held it until daylight, when the main body reenforced them.

The bombardment of the walled city on the 13th and the night attacks of the Japanese, followed by the explosion of the gate, so demoralized the Chinese army that it fled to the northward early in the morning, leaving the city to the foreigners. The Japanese marched through and went out at the North Gate, capturing the fort and battery there, after which the walled city was allotted in sections to the British, French, Americans and Japanese, who immediately began to remove the dead from the streets and walls.

which the Chinese were defeated, and on the following day at Yangtsun they made another stand, but were driven out, the Americans losing heavily in the attack, and later from the fire of the Russians owing to an error. From Yangtsun to Tungchow there was little fighting, but the march was very trying on account of the heat. After a short rest at the latter place the allies moved on Peking, the Japanese and Russians attacking the north wall, the British the east wall, and the Americans the south wall, all entering the city after very little opposition and finding the legations still holding out against heavy odds.

With the relief of the minister, the operations of the American army were practically over with the exception of a fight of the 6th Cavalry, together with a detachment of the Bengal Lancers and some Japanese troops against a force of about 4000 Boxers six miles from Tientsin on the 19th. After considerable skirmishing, the 6th Cavalry made a charge, routing the Boxers and killing over 400 of them.

After the first few weeks of operations it was readily seen that the Japanese army was far ahead of all others in organization, discipline, endurance, equipment, and second to none in fighting. The detail to which their organization was perfected could best be seen on the battlefield, where their ammuition supply was so perfect that, besides looking after themselves, they still had time to assist the British and Americans in bringing ammunition from the city for the troops under fire. Our own wounded can testify to the efficiency of the Japanese Field Hospital Corps at Tientsin, even when the Japanese loss was over 18 per cent of the troops engaged.

Besides observing the relative merits of the various troops off duty as well as in the field, there was abundant opportunity to study the various methods of landing from transports under varying conditions. In the beginning the Russians and the British used large lighters towed by tugs, but this was advisable only when the lighters could be towed direct to Tientsin without stopping and the troops marched ashore. The best method of landing troops from outside the bar, and the one finally adopted by all nations, was to use light-draught river steamers which would carry from one to two battalions with supplies enough for 48 hours. These could load in all kinds of weather, were of only slightly greater draught than the lighters, and having their own steam were independent, so that in the river they were muc safer and more easily handled, while the men were more comfortable on board and could be landed in better condition. Similar steamers were used for landing horses and artillery, and whil slightly more expensive than lighters, they were also more expeditious and, under the conditions obtaining at Taku an Tongku, much more practicable, as there were landing docks t which the steamers could be made fast at any stage of the tide.

After landing, the troops were transported to the front i various ways, the Russians and the Americans using the railwa almost entirely, although some tugs and lighters were also used o the river. The British used tugs and lighters after their troop had been landed from steamers at their station at Sin ho, a fe miles above Tongku. The Japanese used the railway until it wa turned over to the Russians, after which they marched the troops overland via the Taku road to Tientsin and found it very practical method, their men arriving in good condition an ready to take the field.

The greatest objection to using long lighters was the danger grounding in the river bends at high water or on a falling tid and having to remain until the next high water, frequently blocking the river or forcing other vessels aground.

The naval operations in this war were necessarily confined, bu nevertheless important, for besides keeping communication ope between the armies and the outside world, the various navi kept the few Chinese ships blockaded so that they could not interfere with transports or the landing of troops. Early in th struggle the greater number of the men on shore were marine and bluejackets who had to receive all supplies from the ship A number of naval guns were landed, mounted on improvise carriages and made to do excellent service in the fighting Tientsin. And the old Monocacy, although she took no part the fighting, did sufficient good work as an international hea quarters while she was in the river to cause her to be remembered by all nations which took part in suppressing the " Boxers

DISCUSSION.

"TORPEDO OPERATIONS IN NAVAL WARFARE." See No. 95.

Lieutenant-Commander W. **IRVING CHAMBERS**, U. S. N.—The lecturer admits that warfare by diagrams is a highly unsatisfactory though excellent mental exercise, and I agree with him. It is like any game in which chance as well as skill enters as a factor. The subject is treated in a systematic way that shows an intimate knowledge of the present state of torpedo warfare, and I am entirely in accord with him in the main. I wish, however, to point out a few particulars in which I differ as to detail.

1. In regard to the balance adjustment of the gyroscopic steering device, I presume the lecturer refers to the difficulties experienced with the instrument now in common use. I am confident, however, that the newer instrument will be provided with a fixed or shop adjustment which will permit of disassembling and of rough usage without danger of disturbing this adjustment. At any rate, I don't think the mechanical difficulties in the way of accomplishing this end are so great as to justify the tactical conclusion that the instrument will not be used far from a base or position suitable for readjusting it.

2. As to the attack by torpedo-boats, the occasion is one during which boats and quarry are obscured. The boats do not know the exact position and heading of the quarry until they are almost "on top of him." They are going at full speed straight for him, after the alarm is given, expecting to discover his heading and movement in time to pass across his stern or bow, but always to leave him on the port or starboard hand, as specified in the "plan of attack" agreed upon. There is to be no circling about until well beyond the quarry, and then all are to turn in a direction before agreed upon and rendezvous in a predetermined way. I should, therefore, prefer to have the torpedoes of two tubes on the engaged side, one at 20° to 35°, the other at 45°, and both with gyroscopes set so that the torpedoes would pursue courses parallel to the keel after they had turned through those angles. The gyroscope of the third tube I would have set at zero and the tube ready to train in any direction for a chance shot, direct, at short range, at some other ship, or for a parting shot at the first ship, according to the opportunities presented. This, of course, is a matter about which there will probably be diversity of opinion.

3. I agree with the lecturer in setting the gyroscopic gear for certain angles before advancing to attack in the case of torpedo-boats, which operate at night or when the quarry cannot be clearly seen; but when

using torpedoes from ships I would prefer to be able to change thi adjustment at will. This adjustment is simple and can be made almos instantly at the side of the tube and just before firing. It simply re quires the turning of a small crank (one turn representing a change o 10°) until the pointer shows the number of degrees desired. It does no necessitate any "handling" of the torpedo—unless the lecturer refers t the way it is installed in certain foreign torpedoes—so that it is possibl for an observer in a protected position, with a chart of the possibl curves of the torpedo (all referred to the keel line of the ship) befor him and an alidade pointing constantly at the enemy, to know at an instant at what angle to set the valve of the gyroscope, in order to hav the torpedo strike the enemy at the end of the interval of time require for the torpedo to make its run. These angles can readily be anticipate in ample time to communicate with the torpedo-room and have th adjustment made or changed as desired.

4. A torpedo should always be aimed at a ship's broadside and neve directly at either end of a ship. One of the main ideas governing th design of this new gyroscopic steering gear was to make it possible fo a torpedo to be aimed so as to strike the broadside of another shi approaching end on. Take the case of a ship provided with two sul merged tubes at right angles to the keel line. If another ship, say 30 feet long, should be caught in her wake, or nearly so, end on, the fir of both torpedoes could be converged across the stern to strike the broad side of the approaching ship, when it has arrived at the desired di tance, say within 600 yards of the position at which the torpedoes we fired. And the target presented would permit an error of about 10°, 5° each way, in the setting of the valve. With the 5-meter torped having a tactical diameter of 300 yards, the case is analogous to aimin a torpedo from each of the extremities of a base line about 600 yar long at an intermediate object 100 yards long, perpendicular to and 6 yards from the base line.

I mention the case of a ship approaching from astern because certa theorists, who have threshed it out diagrammatically, claim that it easiest for a ship to deliver a ram attack by approaching astern of t ship to be attacked.

There was a time when the end-on charge or the ram attack, bows or bows crossing, was considered the first aim or object in a nav mélée, or even in an engagement between two ships, and this may ha been in the mind of the lecturer when he denounced the torpedo as defense against the ram. Contrary to his conclusions, however, I b lieve that the torpedo has no place on board of a ship unless it can regarded as a defense against the ram. I believe that it can be used such a defense very effectively. I think that the bows-on charge will used only as a last resort or accidentally, as when two ships find th cannot escape it. At any rate, it is a demonstrable fact that the sure and easiest way for a ship to deliver a ram attack is to do it in chase her antagonist; therefore it is a comforting thing for the ship bei chased to have a ready means of defense by torpedoes and to know th the chasing ship cannot use her torpedoes as soon as the ship being chased. I dwell upon this because I differ entirely from the lecturer when he says: "I believe no officer will ever do anything with the torpedo who waits for his enemy to come within reach. There is but one way to use the weapon, even in the defensive, and that is to go in search of your adversary and deliver upon him the most vicious attack that you can possibly contrive. . . ." Now that is just what would be expected of an ardent commander conscious of his superior speed. But in single engagements outside of torpedo range, one rule may be laid down: *You can always bring your adversary to bear either directly ahead or directly astern.* And if you have the nerve to turn away and bring the fast antagonist in your wake, you have the very best chances to torpedo him when he gets close enough. The probabilities of the case are that the slower ship will have the more powerful armament and best armor and that, with the faster adversary astern and the range changing in the slowest possible way, the vicious attack will be settled by gun-fire long before there is a chance to use the torpedoes. I don't say that I advocate these tactics for the slower ship; but I am not one to sneer at the idea when the advantage of having the enemy in your wake is suggested, because I believe it requires more nerve, less recklessness and more skill to maneuver in this way. Nevertheless, I can readily imagine that the "stern-to" tactics might come about as a matter of course, or by orders, in a fleet action where, in case of a separation from the rest of the fleet it would be tactically imperative to rejoin the other part or to place the superior force astern in an endeavor to lure a portion towards the united body of your own force.

In a bows-on ramming attack, I also think the slower ship would have a trifling advantage in the use of torpedoes for defense when capable of quick adjustment for the angle of run. Owing to the uncertainties attending this reckless form of attack, in which a superior vessel subjects herself to possible annihilation by an inferior one, it is impossible to set the angle of the torpedo beforehand to cover all the changes that may ensue; but if the angle may be quickly changed to meet the conditions at a critical time, one or both ships are sure to be torpedoed, and therefore the "vicious" attack is apt to be confined to gun-fire until some advantage be gained. This is, of course, giving your antagonist credit for equal skill in handling both ram and torpedo.

5. In regard to submarine boats, of course they are for use in daytime, *i. e.*, they may be used during daylight when it would be folly to use surface boats. They are necessarily slow, but I fancy that the difficulty of seeing or of navigating them as intended will be no greater than that attending the surface boat on a dark night; but when the boat comes up for a final sight to point her submerged torpedo, her chances will be rather slim unless she can quickly adjust the angle of the gyroscope. In other words, she cannot depend on a fixed adjustment of that angle. Fortunately, we are able to quickly adjust this angle from 0° to 140° on either side of the tube.

Before leaving this friendly criticism, I wish to strengthen the lecturer's remarks by inviting an inspection of the charts of the Maine coas Take Casco Bay, for example, C. S. Chart No. 315, where there ar many ideal positions inviting their seizure as bases of operations by powerful naval antagonist. These positions would be difficult to defen by guns, mines and army alone; but they are, fortunately, ideal position for the operations of torpedo-boats in defense.

I wish to mention some important things that are absolutely essenti to the success of a torpedo-boat, because in some of our latest boa they have been neglected.

1. No torpedo-boat should be obliged to rely upon the ordinary bel pull and gong for communicating orders from conning-tower to engin rooms. The best arrangement is that on the Porter and Dupont; tha on the Dahlgren and Craven is absurd and fatal to success.

2. The reversing gear of the engines should infallibly admit of engin being instantly reversed from full speed ahead to full speed astern.

Captain CASPAR T. GOODRICH, U. S. N.—It is always pleasing and i structive to read the opinions of an author who is fully possessed of h subject and who has the rare faculty of expressing himself clearly ar gracefully. The torpedo could certainly have no more convincing adv cate than the able lecturer of the Naval War College whose address the subject of the few and unimportant observations I may have to offe There is, in my judgment, no surer road to correct theorizing than th ardent exposition of any given thesis by one familiar with its detail followed by honest discussion on the part of those who do or do n agree with the pundit. In many respects I find myself among Lieutena Chandler's disciples; in others, I am forced to range myself among th sceptics.

I cannot share with him the belief that torpedo vessels of forei powers need not be looked for on our coast simply because there a in certain European navies extreme partisans of the torpedo who w doubtless succeed in impressing their views on the technical details the campaign; and not because such measures are commendable. Here the lecturer and I are really at one. We both think this employment the torpedo vessel essentially unsound. Our only difference is that credits the foreigner torpedo enthusiast with an openness to logic whi I am disposed to deny him. The untoward result of so incorrect a use the torpedo the lecturer has accurately noted. If the torpedo vess come they will, as he points out, prove more of a hindrance than a he to the escorting fleet.

For all practical purposes, the lecturer's analysis of the general strateg situation—" that neither power would try to carry on any serious oper tions near the bases of the other until the hostile heavy fleet had be driven out of being "—is true.

It is with reluctance that I find myself again compelled to cry o against the oft-recurring proposition to subdivide and localize our d fence. As Sir George Clarke, the ablest living writer on military affai expresses it: " The sum which a nation can spare for naval and milita purposes is practically limited, and all superfluous expenditures upon coast defence entails loss upon the *sea-going fleet** and the fleet and the field army, which are the real arbiters of war. . . . Americans who have marked the vigor and the initiation, the skill and daring displayed by their navy in the recent war cannot fail to understand where lies the true defence of their coast." We of the navy should not abate one jot or tittle of the contention that in its sea-going fleet our country must and will find all possible guard against serious harm. Whatever will tend to aid the fleet in this work deserves consideration and sometimes acceptance, but everything afloat must be under the absolute orders of the commander-in-chief. His powers cannot be shorn if he is to be held—as he ought to be, and will be—responsible for results.

This torpedo flotilla based on the assumed need of self-sufficient strength at each point is but the cropping out afresh of the old idea which Proteus-like appears in every generation to bring confusion into our councils. To it we owe the gunboats of Jefferson's time. To it we owe the recently constructed monitors.

There is no more important lesson to be taught our non-combatant population than a generous trust in the navy for its defence. To pile up needlessly elaborate fortifications, to place monitors and sections of torpedo-boats at every point of our coast is to stimulate a sense of unrest and an apprehension of danger which will inevitably render each community clamorous for more and still more protection, no matter how much other cities or states are sacrificed.

In saying this I may be entirely wrong, but I hold that the burden of proof rests with him who proposes so large an expenditure on a special weapon as the lecturer's scheme of 231 torpedo-boats would involve. My part in the discussion is done when I say that I see no possible necessity for such a development, that I do not accept the basis of subdivision and localization, and that I am quite ready to be convinced of my error. He has the floor and the attention of the whole service. If he can establish this fundamental point beyond peradventure, we will all join with him in furthering his ends.

If my expressions appear to be strong, they must find their excuse in a profound conviction that the policy suggested is one which should be combated seriously and unremittingly.

The lecturer's section "Approach to the Enemy" is admirably conceived and worked out. His method of solving the problem "By assuming the most favorable circumstances I could think of, I have been able to represent certain maneuvers as carried out in what I consider to be the theoretically perfect manner" being correct, he need not fear for his results. They commend themselves to general approval. The same may also be said of his interesting and instructive studies of other torpedo-boat tactics.

The proposition to hamper our battleships with torpedo launches does not strike me favorably. Many things that might be useful under certain

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* The italics are not the author's.

conditions are omitted from a vessel's equipment, and I am quite
that the torpedo launch does not come under this category.

On the value of the torpedo-boat in coast defence, there is little
ence of opinion. This seems to be its especial rôle.

The lecturer realizes the chance of fatal error when torpedo-boats
used in fleet actions. I find that in reading the lecture over for the
time I pencilled these words in the margin of paragraph 38: "Does
this seem to depreciate the value of the torpedo-boat in this connectio

For the automobile torpedo from shore, I strongly recommend
substitution of the dynamite gun. It has longer range, more accur
of aim, swifter flight, greater explosive charge.

Sooner or later I am confident that a true appreciation of the torp
will prevail, that it will be recognized as a special tool requiring spe
appliances for its use, and that it will disappear from all vessels ex
those built to carry it as their chief or only means of offence. We
wise, in my judgment, to abolish the torpedo from our cruisers. I
pect to see it taken out of our battleships before many years. Its
reason of existence lay in that it was the tactical reply to the
The lecturer throws doubt on even this employment. Let it go.
gun is the real arbiter of actions between ships. In these days of qu
firers it is difficult to imagine even two armored vessels getting wi
reasonable torpedo range without one's punishing the other beyond
elastic limit. I do not mean to say that a torpedo might not poss
be useful on occasion, but I think the occasion so unlikely to arise
the battleship may properly take that chance and get rid of a wea
that is bothersome in itself and bulky in its mounting and its accesso
However, so long as torpedoes are still retained on heavy ships,
captains will do well to study attentively the excellent suggestions
by the lecturer in Section D of his address.

In referring to submarine boats, the lecturer very quietly gives
the thrust of Ahab, when he says "it is no more possible to see u
water than it used to be." Personally I think attacks from balloons
find their place in serious naval warfare about as soon as attacks
submarine boats. I had always hoped that their development
remain the exclusive monopoly of the French and Spaniards. I
sorry to see the Anglo-Saxon mind distraught by such spooks.

In his summing up, the lecturer has put the gist of torpedo wa
into a few plain phrases. Practically he says that a man who is b
to have *your* life even if he has to sacrifice *his own* is a dangerous fel
Put such a man into a torpedo-boat and the enemy must needs ke
bright lookout, have plenty of patrol boats, be always on the m
always on the alert, or his doom will be sealed, no matter whether
torpedo man has the latest mechanical devices at his command or
There is nothing in the history of our navy to indicate the lack of
officers when they are needed. But cool and brave as they may be
nature, they will be better able to translate wishes into deeds if
read attentively this essay which Lieutenant Chandler has so favored
navy by writing.

Lieutenant R. C. Smith, U. S. N.—The lecturer adopts a very prevalent view, that the destroyer is simply a large torpedo-boat. But is there not room also for the opposite view, that the destroyer is only incidentally and occasionally a torpedo-boat, and primarily a gunboat to protect the fleet against torpedo-boats? A fleet on the enemy's coast at night really has no other defense against torpedo-boats. A cordon of destroyers affords a reasonable protection, assuming fleet and boats thoroughly drilled at cruising formations. All who have taken part in torpedo-boat drills realize that the searchlight is an advantage to the boats rather than to the ships, except in the one case in which narrow channels are flooded by fixed beams, as was the case at Santiago.

The fleet at anchor may have vedettes and pickets inside the destroyer cordon, but at sea destroyers only will be available. The launches mentioned by the lecturer are in effect the English vedette launches, and we could not do better than carry one or two of them in all our heavy ships.

As to sending destroyers abroad, if the fleet goes, it is hard to see how they are to be dispensed with, provided the enemy has torpedo-boats. It is true the Spaniards did not have great success, but that is hardly a criterion. A destroyer of 400 tons with liquid fuel and a trained crew, not a crew of officers and men put aboard for the trip, ought to be able to go anywhere.

But leaving out the question of destroyers, every one must realize that if torpedo-boats have a mission anywhere, it is right on our own coast. If the enemy cannot bring over destroyers, so much the better for our boats. And as to organization, Lieutenant Chandler's district scheme seems perfectly feasible.

The Germans have spent much time in perfecting the tactics of boat attacks. It is hard for an outsider to see the value of their very close order formation, except as a training in maneuvering. It, of course, ensures that the attack by all the boats should be simultaneous, but if the boats could separate earlier and come in on entirely different bearings, the chances would apparently be more favorable. Drills undertaken on our own account could determine some of these points.

The lecturer's stand in reference to the character of installations aboard other than torpedo vessels does not seem open to criticism. It it probable that many officers would like to see torpedoes relegated to torpedo vessels exclusively. This would simplify matters, but as long as the weapon continues to improve in range and accuracy, and is included in the armament of foreign battleships and heavy cruisers, no one nation can afford to take the lead in dispensing with it.

Torpedo stock, for a variety of reasons, is at low ebb with us at present. The Spanish war is partly responsible, not only in the popular mind, but even in the service itself. Officers who have given thought to the matter and have some practical acquaintance with the weapon know that there was not an atom of evidence either for or against torpedoes. The present scarcity of officers and men is no doubt the main reason for not keeping the flotilla in commission. Yet the boats are much needed for

drills and exercises to settle many of the points brought up by Lieutena
Chandler and to train and develop the personnel. A boat laid up
ordinary is supposed to be ready to take the water and move out at
couple of days' notice. Officers, however, who are familiar with t
duty, know that such a boat with a pick-up crew will not reach a poi
of efficiency inside of six months.

The moral, then, is that to develop a torpedo system, we need dri
with ships and boats afloat, we need the boats in commission, and
need officers and men to man them and stay in them long enough
show what can be done with them.

Lieutenant John M. Ellicott.—Lieutenant Chandler has gone in
the subject so thoroughly that I would refrain from criticism if I did n
differ most radically from him on one point; viz., the section formati
for seeking and approaching the enemy. That, I think, would be
tactical blunder for the following reasons:

(*a*) It reduces to a minimum the chances of finding the enemy; sev
boats searching in a bunch having no better chance than any one
them searching singly.

(*b*) It raises to a maximum all the causes tending to discovery, su
as the bow waves, the phosphorescent wakes, the volume of smoke, t
volume of noise, the flaming and sparking of funnels, and the size
visible target.

(*c*) It insures the discovery of all the boats at once if any of the
multiplied causes draws attention to the section.

I think torpedo-boats should go out singly, by as many different exi
as possible, and at quite long intervals apart; the boats to seek sep
rately certain stations enveloping the enemy, but beyond range of di
covery; then, at a certain time, which by prearrangement will ha
allowed all to reach their stations, all the boats should concentrate
slow speed toward the supposed center of the enemy's formation. Wh
any one boat is discovered by a vessel of the enemy before successfull
discharging a torpedo, all neighboring boats should concentrate upo
that vessel.

My tactics would be dispersion for search; concentration for attack.

Lieutenant J. Hood, U. S. N.—I have read Lieutenant Chandler
lecture on "Torpedo Operations in Naval Warfare" with great interes
and find in it much to be commended, and all to be of value, as openin
up for study and discussion many points of torpedo warfare but littl
considered by the average naval officer.

While not quite the enthusiast on the subject of the torpedo as
naval weapon that the lecturer is, I am a firm believer in its great use
fulness and capabilities when properly handled; and think Lieutenan
Chandler deserves the thanks of the entire service for ventilating an
bringing into prominence so many points of a weapon that may be s
valuable and that can be so useless when not properly handled an
understood.

In complying with the "Institute's" invitation to discuss and criticise Lieutenant Chandler's lecture, I will only mention a few of the points brought out in which I disagree with him.

1st. I think the lecturer is in error in assuming that torpedo warfare is not to be feared on our own coasts in case of conflict with European nations. I believe that any country with a navy considerably superior to ours—and there are many such—could, and would, bring over and use its destroyers from the beginning of the war, and before our "fleet in being" had either been destroyed or securely cooped up. There are too many bays, sounds, etc., on our coasts indefensible against a largely superior naval force, that such a force would control and use as a base, without necessarily securing a hold on the land itself. It is hardly to be supposed that an intelligent and alert enemy would deprive himself of the use of such powerful auxiliaries, when the means of obtaining them were so easy and feasible. The case quoted of the Spaniards in the late war could hardly be called an illustration of the contrary, as their navy was considerably inferior to our own, and the Spaniards could hardly be called either intelligent or alert enemies.

2d. I think that the lecturer's ideas on the organization of the coast into 25 districts with 175 torpedo-boats and 56 destroyers are Utopian, and, on the whole, unnecessary. Such an extensive torpedo-defense scheme might be necessary were the entire coast-defense system turned over to torpedo-boats alone. But it is out of all proportion to the other necessities of the navy both as it is or even as it should be. It would be anything than good policy to advocate the extension of the torpedo system at the expense of the real fighting force of the navy, as would necessarily follow such an extensive program as that laid down by the lecturer. A quarter of the number of boats and half the number of destroyers suggested would answer all the purposes of national defense; and any further money available for naval expenditure could be far more valuably used in the building of fighting ships proper.

3d. The general statement made by the lecturer, that the great and proper sphere for torpedo action is coast defense, is thoroughly sound, and I agree with him in that entirely. But in the method of conducting this coast defense I believe him to be in error.

Actual experience of both the modern torpedo and torpedo-boat in war has been so limited that little deduction can be drawn from it. But so far as it goes, it would, to my mind, seem to lead to the conclusion that the greater chance of success is with what might be called a "still hunt" by boats acting singly—though all the boats available should be sent out at the same and most advantageous time—rather than by sending them out in bunches or sections to hunt as a pack. Nothing in war is so distinctively "personal" as torpedo-boat work in actual service. Success depends absolutely and entirely on the care, judgment and daring of the individual. Failure on the part of one in a bunch of seven, or any other number, would lead to a detection of the whole, and defeat the attack before it was made.

The case under consideration, and of which the lecturer is treating, is the case of a port blockaded, and an effort is to be made to break up th blockade and destroy as many of the enemy's ships as possible by torpe attacks.

The blockading ships are known to be in the vicinity of the port, ar the torpedo-boats must find them and remain themselves unseen till t moment comes to discharge the torpedoes, or failure is almost certai

The most favorable opportunities are chosen, and the boats are se out to make the attack.

It would seem to me that under such conditions the chances of getti out unperceived and finding and destroying the enemy are far great if the boats are dispersed from the instant of breaking cover, rather th hunting in bunches, and dispersing after an enemy is sighted. Mor over, it must be remembered that the enemy will be dispersed also, a the whole force of the torpedo attack might be expended on one sh when it might be just as easy and feasible to bring down several. O torpedo will sink a ship as surely as twenty.

It may be very pretty in theory, and very excellent seamanship pra tice, to steam about in a beautiful wedge-shaped formation, but it see to me that the seven boats in the wedge would be far better occupi in devoting their whole attention to the stalking of their game; a acting singly would cover much more territory, run less risk of detectio and the detection of one would not necessarily lead to the discovery the others.

In other words, and as a general proposition, I believe that, from t very nature of the case, such a thing as "torpedo-boat tactics" in t face of an enemy is a chimera; and that the whole art consists in t highest possible training of the officers and crews of the boats indivi ally; and then sending them out—as many always as are available—ea to do his best independently of the others.

Lieutenant-Commander **Bradley A. Fiske**, U. S. N.—It would sur be a most unreceptive mind that would fail to be impressed with t enormous possibilities of torpedo warfare by reading Lieutenant Chan ler's paper; and to all, it opens up a wide and entertaining field f thought about torpedo warfare as it now is and torpedo warfare as may be made to be.

While some points might be raised about the details of Mr. Chandle plans, it seems to me that the main point to be considered now whether the torpedo can be made so reliable that torpedo warfare oug to be attempted on so large a scale. If this be answered affirmative both general and special methods of torpedo operations can be work out afterwards in actual service.

To some, it may seem that Mr. Chandler goes too far, that he depen too much on a delicate apparatus, that he hopes to base a system warfare on a mere machine; for there is still a deep-seated mistrust the torpedo, as a weapon to be depended on. We all mistrust t torpedo in fact; and not only for the reason that it is complicated, b for the further reason that it is constantly being changed, and that eve change is an addition, a new thing to get out of order.

If we analyze our mistrust, however, and are candid with ourselves, I think we shall see that it is not the torpedo that we mistrust, so much as the men who are to handle it. The torpedo itself is not alive, though it often seems to be so, and perverse besides; but it is really only brass and iron, and will do exactly what men make it do. So the question seems to me to be, not can the torpedo be depended on to do all the things that Mr. Chandler expects, but can we drill our officers and men so that they can make it do them?

Thus regarded, this question becomes like one presented in every department of the naval service, the question of what degree of complication and difficulty can be managed in any weapon or apparatus, remembering the kind of men who are to manage it, and the amount of skill that can be drilled into them. Probably, all of us agree that the apparatus in our newest ships is superior to the personnel that manages it; and we know that the reason is, that we draw on the highly specialized engineering facilities of the whole world for our apparatus, but only on our meagre stock of officers and men for our personnel; so that, in every department of the service, we are confronted with the question of how high can we raise the standard of the men up to the apparatus, and how far we must lower the standard of the apparatus down to the men. Therefore, in considering the question of employing any weapon, or of employing it in any specified way, we must answer the question: "Is the work which the weapon can do, if perfectly managed, so very valuable that we can afford to devote to it the required money, time and drill?"

Testing Lieutenant Chandler's ideas about torpedo warfare according to this standard, the question becomes: "Are the results attainable, supposing the torpedo perfectly managed, so very valuable that we can afford to devote the necessary money, time and drill to attaining them."

Who can answer this question negatively? Is not the question answered affirmatively as soon as stated? To me it seems that we are forced to develop the torpedo to its utmost, and that we *can* develop the officers and men up to its level. Even specializing may become necessary as the torpedo grows; though specializing has its dangers. But that we can educate men to handle torpedoes in the way Mr. Chandler wishes, who can doubt, that knows the keen, resourceful gunner's mate of to-day, and compares him with the non-cerebrating, gun-polishing quarter-gunner of only a few years ago?

Perhaps I can sum up my comment on Lieutenant Chandler's paper by saying that I think torpedo warfare can be made to be all he says, and that it simply remains to educate the officers and men up to it. That this will be easy work, let no man think. It means hard study and careful thought; it means an intimate acquaintance with every screw and spring; it means ability to diagnose at once any hidden trouble; it means long days and nights of practice in the worst of weather; but it can be done.

The fact that the torpedo has recently become effective at 1500 yards; that the torpedo just developed is fully twice as efficient a weapon as that of only two years ago, and that improvements of various kinds are in plain sight, seem to force us to the conclusion that we absolutel must educate our officers and men, first to manage the torpedo itsel and then to conduct torpedo operations.

Lieutenant W. S. **Crosley**, U. S. N.—Though invited to criticise t article written by Lieutenant Chandler for the Institute, I cannot, the main, do so. From a brief personal experience in a torpedo-bo I have been forced to certain beliefs in regard to their use, and I hearti endorse Lieutenant Chandler's article as a whole.

I believe fleet or section tactics with torpedo-boats in time of peace be indispensable to their satisfactory performance in time of war, a will be glad, indeed, when one or more "district bases" can be esta lished on our coast.

Doubtless paragraph 14 in Lieutenant Chandler's article is not lon because the ground has been covered by Lieutenants Koester and Ja son in previous articles, but to me it is a question worthy of mu consideration.

The importance of a suitable base, where spare parts for all machin needed in a torpedo-boat, including those for the torpedoes themsel would be available, and where work with machine tools could be do is great. The idea of a torpedo supply vessel, carrying lighter torp craft, seems excellent.

It has been my experience that the crew of a torpedo-boat can depended upon to execute all repairs incident to service, if the necess facilities can be furnished.

It seems to be conclusively proven that torpedo-boats and destroy are not available for offensive warfare upon a coast removed from own. Certainly but little need be feared from torpedo-boats which h crossed the Atlantic until they have had an excellent opportunity recuperate both material and personnel.

In this connection something might be said of the absolute neces of "nursing" torpedo craft. They are necessarily delicate, and to efficient must be in the best possible condition for their efforts. T "nursing" must come from the highest authority, for it cannot be lieved that an officer commanding a torpedo-boat would object to duty offered his boat in time of war. It is to be expected that s craft may be sacrificed, yet great should be the necessity when they called to do duty other than that for which they were designed.

In my opinion great care should be exercised concerning the p sonnel of torpedo-boats. At best life upon such craft is a hardship, there should be available at the "bases" quarters for those attached the boats, yet at the same time the boats should be in constant empl ment.

I believe that the best care can be taken of torpedo-boats by runn them frequently at ordinary power, and occasionally at full power.

As for the men employed, the best man aboard a battleship may quite unfitted for service on board a torpedo-boat, and I am strong the belief that a man found valuable for torpedo service should retained for that service. This applies especially to those connected with the engineer department of torpedo-boats, but I believe in a picked body of men who shall be available for torpedo service only.

Lieutenant J. L. **Jayne**, U. S. N.—I think the lecturer deserves to be congratulated for the able manner in which he has handled the subject within the limits he laid down for himself. I agree with him heartily in the idea of dividing our coasts into districts with shore bases for torpedo purposes, and in the idea that "the boats should be continuously exercised in everything pertaining to their war service, keeping men and material tuned up to the highest pitch, while the officers should make themselves familiar with the pilotage of their districts until they can take their boats everywhere under all conditions." Of course this necessitates operations with and against the fleet at times, and I would take advantage of such operations and of the presence of the destroyers (which should accompany the fleet habitually in somewhere near the proportion required under war conditions) to give as many of the officers and men of the fleet as practicable experience, not only of resisting attacks, but of service on the boats in the various duties that they might be called upon to perform in war. A record should be kept of all officers and men who have had any torpedo-boat duty, giving the nature of it, the time employed at it, and the aptitude for it, and also the name of the boat or boats on which it was performed. Such a record might be of great value to the Navy Department or the commander-in-chief in making up crews for new boats or new crews for old boats or in filling vacancies which may occur. It is true that each boat has its peculiarities, and officers and men must become familiar with them before they can get the best results, but men who have had experience with similar boats can gain that familiarity more quickly than those who have not had such experience. For this reason the boats should be as near a standard type in every particular as is consistent with the spirit of progress.

The necessity for training a large percentage of the personnel in torpedo-boat work and keeping a record showing individual aptitude for it was very forcibly brought to my attention at the outbreak of the Spanish-American war by an unhappy experience that I had for the lack of it. As it seems pertinent to this subject, and as it may serve as a warning for the future, I will give a brief account of it here. I was assigned to the command of the Rodgers, fitting out at the Norfolk Navy Yard, when war with Spain was imminent, and one of my first acts after arriving at Norfolk was to appeal to a friend in the Bureau of Navigation for his aid in selecting a good crew for her. I was particularly anxious to secure a man for chief gunner's mate who had had experience with torpedoes and the best men available for machinists and water-tenders. Aside from the well-known intricacy of torpedo-boat machinery, the Rodgers had had several unsuccessful trial trips, sustaining serious damage in one or more of them, which had delayed her completion several months, and was finally accepted when war was imminent, after a trial much less severe than it would have bee another time, and with this knowledge I felt that I had an exce reason for requesting picked men in the Steam Engineering Departn especially as I was to have no engineer officer. I may add right that it is too much to expect of the commanding officer or the junior officer of a torpedo-boat to act as the engineer officer, supposing they have the aptitude for that duty, under conditions as we on the Rodgers had to contend with. The Department sen a good gunner's mate, but my friend in the Bureau of Navigation me that it was hopeless for him to try to pick machinists and w tenders. Therefore, I was left to select the crew from the few available at Norfolk. My two chief machinists were tugboatmen. of them had great possibilities but lacked experience with such ma ery as the Rodgers had and was so subject to seasickness in bad we as to render him almost useless at such times. I soon had to leave in a hospital at Key West. The other man was very different eventually, giving up all hope of his ever being able to fill the pla exchanged him for a man on the station ship, and I afterwards lea that he was not giving satisfaction at running the engine of a launch. In the seaman branch, too, the crew was far from perfect. such a crew, after a few runs in Chesapeake Bay and a little to practice, we started for Key West, where we eventually arrived many mishaps. I had anxiously hoped upon arriving there to be to exchange some of my men for more experienced ones, at accustomed to blue water, even if they had not had torpedo-boat vice. To my great disappointment, I found that this was a very di task, as every commanding officer jealously guarded such good m he had been fortunate enough to get. Some changes were made time to time, however, and notwithstanding such a great handica succeeded in keeping our boat at sea with the fleet off the north of Cuba for two weeks at one time and taking her to Santiago with Shafter's army; but this was done at the expense of keeping the of and crew under a tremendous strain (some breaking down und and nearly using up the boat.

Now the point I wish to make is that much of this might have avoided. The two boats of the same class as the Rodgers had be commission for some months prior to the commissioning of the l and during a considerable part of that time had been with the fleet near Key West. Had the plan proposed above of giving the m the fleet experience on the boats acting with it been carried out i case there might have been a number of them showing aptitude fo duty sufficient to fill the complement of the Rodgers, without takin many from any one ship; and it seems reasonable to assume that such a crew much of the trouble might have been avoided.

Even after an experience so full of mishaps as that on the Rod I cannot agree with the lecturer in his opinion "that it would be difficult to conceive of even destroyers being ordered to accompan fleet in an expedition against an enemy in his own waters." Pe that experience, together with a knowledge of the experience of some of the other boats, enabled me to see more clearly the possibilities of keeping at sea in large torpedo-boats and destroyers than if it had been less checkered. That the Spaniards made such a poor job with their destroyers does not prove that other destroyers manned by other men cannot accompany a fleet across the Atlantic and there do effective work.

I have not had any experience with liquid fuel, but I believe experiments with it have proven that it can be safely used. If this is true, its use on torpedo craft will greatly simplify torpedo-boat service and render refueling at sea a very simple matter. This of course is a very important consideration in any kind of operations on an enemy's coast. I would like very much to see it applied to a destroyer and her sea-keeping powers demonstrated. The imperfection in the gyroscope that the lecturer mentions is a very serious one, but I expect to see that overcome. Even without the gyroscope destroyers might use their torpedoes effectively if the officers and crews are highly drilled in using them, and they can be used to guard the fleet from the enemy's torpedo-boats even without torpedoes.

In my opinion the following points should receive proper attention to make a success of destroyer service:

1st. The destroyers should be thoroughly tested before being sent on war service.

2nd. They should be manned by men who have an aptitude for the work with considerable experience and not liable to seasickness under the conditions that would exist on board in bad weather.

3d. There should be three or four officers for each destroyer which will be required to keep the sea for a considerable time, one or more of them to thoroughly understand the engines and boilers.

4th. When the boats are operating with the fleet there should be two crews, the relief crew having quarters on board a supply-ship or battleship.

5th. Every boat should be provided with efficient arrangements for towing and being towed, and advantage should be taken of every opportunity, when military and other necessities do not prohibit it, to have the battleships or other large ships tow them and thus relieve the strain on the machinery and personnel. On long passages this would be of great value in preserving the men and boats.

6th. Arrangements should be made for supplying water and liquid fuel, if it is used, from the large ships. This can easily be done while towing.

7th. There should be a large ship provided as a supply and repair ship for the boats, or the large ships should be required to render such assistance when necessary.

8th. Destroyers should not be required to do despatch-boat or other duty foreign to the objects for which they are designed, except in emergencies when it cannot be avoided, and all persons in positions requiring them to direct their movements should be thoroughly aware of the limits of their capabilities and the hardships attached to service on board of them under war conditions.

PROFESSIONAL NOTES.

TELEGRAPH CABLES IN TIME OF WAR.

From the French of J. Depelley. Translated by Lieutenant J. Hood, U. S. N.

The first words exchanged between Europe and America by the trans-Atlantic cable of 1858 were the words of peace, which claimed the neutralization of telegraph lines, the President of the United States claiming in his message of felicitation to Queen Victoria that all civilized nations should spontaneously, with common accord, declare that the electric telegraph should be forever neutral, and that the messages which should be confided to it should be held sacred, even in time of war.

This wish, emitted in the enthusiasm which was born of the first telegraphic communication of human thought between the two continents, was not destined to have a near realization. After forty years the neutralization of cables is not yet recognized. It will, apparently, be a matter of the future; but for the present a submarine telegraph is a powerful instrument of war at the profit of the country which has had the foresight to assure itself of its services.

As soon as the possibility of corresponding at great distances by means of submarine cables had been practically demonstrated, England understood what a commercial and political preponderance would be given to her by the creation of a grand network of cables under her control. Without being discouraged by the onerous failures at the beginning, with a perseverance that one should admire, she has succeeded in creating and developing methodically, without noise, and without rest, a network of submarine telegraph cables which cover to-day the entire world; enclosing it in an immense net of copper, of which London is the center. It is there that the threads of this net converge; and in the whole world not an incident occurs, not a political or commercial fact, of which the news is not first transmitted to London. It is a marvellous agent of information and influence that England has in her hands, an agent so much the more redoubtable that other countries are deprived of it.

A simple examination made of a telegraphic chart shows the grasp of cables belonging to the English companies, and explains certain difficulties of our colonial policy, and throws a little light on facts which have sometimes appeared incomprehensible.

In the direction of North America, ten trans-Atlantic cables connect England with Canada and the United States. Further down towards South America, three other English lines traverse the Atlantic and connect Brazil to Portugal and Spain; and, by their prolongation, to London itself. Other English lines extend from north to south along the Pacific coast. Still others develop all the Antilles and Central America and complete its first net, which puts the whole of America at only a seconds from London.

Towards the east, the English lines which extend in that direc starting from London, quadrupled at certain points, turn Europ Gibraltar, touch at Malta and at Egypt, on through the Red Sea to A

At Aden is found what one might call the knot of the telegraphic l the importance of which is revealed to-day. From there, in fact, s the first section of the three cables which extend towards India, which are prolonged by other lines to China, Australia and New Zeal Another line starts from the same point, extends along the eastern c of Africa, connecting it to Zanzibar, Mozambique, Delagoa Bay, N and the Cape of Good Hope. This grand eastern network has its ce point, where all the lines converge, at Aden.

Towards the western coast of Africa, the same English lines w connect London to Portugal and Spain, extend first to Bathurst b Senegal, then, from there, festoon the coast as far as the Cape, w they rejoin those from the eastern coast, enclosing the entire Af littoral in a circle of English telegraphs.

There also, it is necessary to remark, are the complete conditio control with regard to England, in which this network is constru In the same manner as by the east, Aden is the point of convergen all the lines which spread out towards the Indies, China and Aust and towards Africa as far as the Cape of Good Hope; just the sam the western coast of Africa, a point of convergence of all the lines e in English territory at Sierra-Leone, and above all, at Bathurst. Thr these English stations necessarily passes all the correspondence o network which extends along the coast as far as the Cape, and w serves the French and Portuguese territories, which, by the way, la subsidize them.

The importance of the danger of this organization to all that is English is immediately apparent as soon as one sees the clauses i contracts which the English government imposes on its telegraph panies. Here are the principles: They suffice to show in a suffici strong manner the political views which have guided our neighbo the so persevering creation of their telegraph network.

"Article 3. The proposed cable shall not employ foreigners at station. In like manner, the lines will not pass in any office which c be under the control of a foreign government.

"Article 5. The Government of Her Majesty does not make engagement, or take any responsibility, in anything that regards cable beyond the payment of the subsidy.

"Article 6. The subsidy will be given during twenty years, and able at each complete period of twelve months, under the condition the cable be maintained in a good state and shall have rendered service, and that the service between the United Kingdom and colonies and English protectorates shall not be subject to interrupti

"Article 7. The dispatches of the imperial and colonial govern shall have priority whenever it is demanded. They shall be transm at half-rates, which shall not exceed a sum to be determined.

"Article 9. In case of war, the Government may occupy all stat in all territories which are English or under English protection, may use the cable by means of its own employees."

Thus in normal times the British government is especially assure its despatches, wherever an English telegraph line exists, of a right of precedence which belongs to all despatches which are official according to the international conventions. The reservation of this privilege may appear natural; but, in reality, it has for its end and effect, to give precedence to all English despatches over all official despatches of other countries. It is not necessary to search further for an explanation of the difficulties or delays, so favorable to British interests, which certain telegraph despatches are subject to.

But how much more dangerous is the situation in case of war. The events in the Transvaal should open the eyes of all countries to this menacing peril. Not only the English censorship established at Aden refuses cipher dispatches coming from Marques, from Durban and the Cape, but stops also those which come from Madagascar, as well as from German East Africa. What would it be if, instead of war between England and the Transvaal, the hostilities existed between England and France? It is the question of the rôle of the telegraph cables which is plainly exposed by these facts. What has been this rôle up to the present? What will it be in the future for a country, like France, which has an immense colonial empire to defend, and traditional interests of influence and commerce to sustain in all points of the globe?

Although of an origin very recent, since it goes back scarcely forty years, the telegraphic cables have already mixed themselves so directly in the colonial and maritime international life of all nations that the interest and importance of their existence can no longer be ignored or misunderstood. Notably in time of war they can be the means of action of such weight that one may justly say, that the nation that could alone control a network of submarine telegraphs, to instruct its squadrons of the movements of forces, and the strength of the adversaries, will be the mistress of the sea.

What is passing at this moment for the correspondence that comes from South Africa marks the dangerous dependence in which all countries are placed by the sole fact of the state of war between England and the Transvaal. The events which developed last year in the course of the Spanish-American war, when two maritime powers found themselves at war, furnish in a still more conclusive manner the demonstration of the influence that telegraphic communication will take in a colonial conflict. It was shown, in fact, that a telegraphic war was engaged in between Spain and the United States from the beginning of hostilities; that it followed on parallel lines to the military operations, where one finds for the first time a collection of facts clearly showing the considerable rôle which the submarine telegraphic lines may have to play in a great war.

With a want of foresight, which should be a lesson to other countries, Spain had remained, up to the moment of the declaration of war, without the possession of independent telegraphic lines between Madrid and Havana. She had sustained for several years against the Cuban insurrection, a war openly favored by the Americans, and she had no other means of corresponding with Cuba than by American telegraph lines. Her official despatches and her secret instructions arrived at Havana by the lines which connect New York to Florida, after traversing the United States and the American cables of Florida. This imprudence strikes us to-day, after the events which they have revealed, and appears incomprehensible. However, we must be indulgent to appreciate it; for other countries, among which France is found, are at the present ho just as improvident, and would be, in regard to their colonial possession in the same situation as Spain if war should be declared.

It was only at the moment when hostilities were openly declared against the United States—that is to say, at the eve of interruption o communications by way of the north of Cuba—that Spain undertook wit some vigor the search for means of correspondence other and more sur than by American lines. It was far too late. It is not by improvised measures that the organization of a telegraphic service can be made fo such a great distance. The other lines which connect with Cuba without touching the United States, come by way of the south, land at Santiago de Cuba at 500 kilometers from Havana. These lines were no prolonged to Havana except by land lines, already in the hands of the insurgents, and by cables submerged along the coast and consequently exposed to be cut. From day to day Havana could thus be isolated fro Santiago, and Spain was menaced with having no telegraphic communication with the principal theater of war, where its colonial fortune wa menaced.

What a difference in the procedure and in the situation on the side o the United States.

On the day that war was declared one of the first acts of the Government was to apply strict censorship on all telegraphic lines that cou reach Cuba. The cables from Florida to Havana, belonging to an Ameri can company, were seized and controlled by the military. All th American stations where other lines touch even indirectly in communica tion with Cuba were equally occupied by military telegraphers. A complete prohibition was applied to the Spanish government despatches, t code and cipher despatches for the West Indies; finally, all writte despatches having a tendency hostile to the United States. These fir measures, rigorous as they were, appeared insufficient. The American wished to completely isolate Cuba by cutting all cables which land o the coast of the island, except the cables from Florida to Havana, whic were already in their hands, and of which one raised on board of a shi of war put the squadron in charge of the blockade of Havana in communication with the Federal Government at Washington.* Three ship were rapidly fitted out for cutting cables, the Mangrove,* the Adria an the St. Louis. On the 21st of April, the day of the declaration of wa the Mangrove left Key West for the south of Cuba, with the order t destroy the cables which land at Santiago; that is to say, the Englis cables from Jamaica and the French cables from Haiti. The Adria an the St. Louis followed several days later, the St. Louis to aid in thes operations, in the course of which these ships were always protected b the ironclads. Other ships were equally fitted with tools and specia engines for breaking cables. In spite of this display of forces, durin several weeks the attempts made were complete failures. The draggin done at some distance from the shore, remained without result. Th Cuban coast presents this peculiarity common to all the Antilles, t descend from a peak to a great depth, in such a manner that at a ver short distance from the beach a great depth of water is found. Dragging for cables is, therefore, difficult if they are not searched for at the shore ends. It was that, after numerous fruitless efforts, the Americans re-solved to do, and even under these conditions they only obtained success by acts of audacity and by running very serious dangers.

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* N. B.—Errors of fact of the writer.

On the 18th of May, the St. Louis, wishing to make a decisive effort to cut, in front of Santiago, the cables from Jamaica which it had uselessly hunted for at sea, commenced to drag for it at seven miles from the fire of Santiago. Little by little, not finding the cable, it approached to within a mile of the entrance of the harbor. At this point it grappled a cable, but at the same moment the fire of the Spanish forts began, and the operation became dangerous; the work was hastened; the cable was hoisted on board; it was cut and the ends hastily thrown into the sea. The St. Louis retired, well convinced that it had interrupted communications with Jamaica. The news was given to all the American press. It was a veritable exploit! It was announced at the same time that the French cable from Santiago had been cut near its landing on Haiti, and that, consequently, Cuba was completely isolated.

And the cable raised was only a piece of old cable abandoned in an ancient repair! This old cable, sunk under the sea for many years, hardly expected to see the light of day under such glorious circumstances. None of the telegraphic lines from Santiago had in reality been injured. As to the French cable, it was never touched on the Haitian coast.

Having recognized the negative results of the expedition attempted at Santiago, the Americans did not acknowledge themselves beaten. They wished to cut the cables which connected Santiago to Havana, in order to isolate General Blanco from all communication by the south, as he was already without communication by the north. These cables, which are developed along the south coast of Cuba, have several landing places. At one of these, Cienfuegos, an attempt at cable-cutting was made under conditions particularly daring.

Cienfuegos is situated within a land-locked bay which one enters by a narrow entrance three miles long. At the entrance of this canal there is a lighthouse on a hill 300 feet high, at the bottom of which runs a narrow sand beach. At a small distance from the lighthouse is erected the cable hut of the cable lines, visible from very far at sea. The American forces united before this point were composed of four ships of war. Two steam launches and two cutters were dropped into the water. Each of the cutters had a crew of sixteen armed men and was supplied with tools for cutting cables. The steam launches were to tow the cutters up to the shore, while the ships, placed at about a mile distance, would bombard the lighthouse and the cable hut.

The operation began at daybreak and was carried out rapidly. While the ships directed a very lively fire on the beach, the boats approached the landing within a distance of 100 feet from the cable hut, already nearly destroyed. The depth of the water was too great to grapple for the cables. To the great surprise of the Americans, the Spaniards did not open fire. The cutters approached to within a few meters of the shore till a depth of scarcely 20 feet was reached, where they grappled first the cable going towards the east in the direction of Santiago. It required 30 strong men from the two cutters to hoist the cable aboard. It was a shore-end cable, thick as the arm of a man, and the weight to be lifted out of the water seemed to be several tons. After putting it on board, it could be cut.

One of the ends, that which went to the cable hut, was thrown into the water. The other was hoisted for a length of about 150 feet, with the

intention of carrying it on board of one of the ships to try to
cate with Santiago; but the weight was such that the boat ne
dered, and it was necessary to rapidly make a new cut in order
the cable into the sea, keeping on about 100 feet.

All these operations were accomplished without the Spaniar
seriously opened fire on the Americans.

The same work was immediately undertaken on the other c
in the direction of Havana. It was only about 60 feet from
that the cable was grappled; while the ships redoubled thei
shells being fired over the heads of the men working in the b
position, however, became dangerous, for the Spaniards com
fire vigorously on the Americans. Shot literally rained about
and already several men were wounded. The cable was cut in
manner as the other and thrown into the sea. In raising it in
depth a third cable had been seen. The Americans wished t
also, and they had already put the grapples into the water t
when the fire of the Spaniards became so lively that the oper
to be abandoned. The cutters were towed to the ships, h
several men. The ships themselves had been seriously tried b
of the Spaniards, since the captain of one of them, the Nash
been wounded. But, by happy chance, the Americans had tru
two cables which connected Cienfuegos. The third cable which
not been able to touch simply connected between the hut and C
and had no importance whatever.

The result of this dangerous operation was of capital v
cutting of the cables of Cienfuegos completely isolated Ha
completely deprived General Blanco of means of communica
Admiral Cervera, enclosed at this time in the harbor of Santi

But in spite of all these efforts, Santiago still remained in t
communication with the outside world by the English ca
Jamaica and by the French cables from Haiti. It was not unt
of June that the French cable was finally cut. The news of the
tion was not incorrect this time. The cutting this time had a
place near the landing end, and in shallow water, and after the
ment of the coast the Americans had chased the Spaniards
interior. The Americans landed troops, and it was at this
commenced to occupy the environs of Santiago.

As to the English cable from Jamaica, it was landed in the
Santiago harbor under the protection of the Spanish fort. It
cut in spite of several efforts, of which the first produced the
error that has been related. All the draggings made in the
were made without any result, and as the landing could no
proached, it was impossible to cut the communication, which
cease to act until the end of hostilities. It appears, however,
been of very little utility to the Spaniards, and to have ann
Americans very little, who had succeeded in organizing under t
tion of a man of great merit, Brig.-Gen. A. W. Greely, a re
service of surveillance on all the telegraph lines which could rea
This service was incontestably one of the features of the succes
Americans, who were powerfully aided by the confusion and dis
ment thrown among their adversaries, thanks to the absence of n
exact knowledge.

In any case, a lesson is taught in a striking manner from thi tion of facts; that is, that contrary to what has been heretofore supposed, the cutting of cables by improvised methods offers very great difficulties. The Americans brought to the work great resources and a considerable force, against a country poorly defended, and succeeded only in cutting some lines, at the expense of very great danger.

Just as easy as it is for a vessel, installed and provided with tools, and with a trained personnel, to pick up and repair a cable, whose position is exactly known, just so difficult is it and little practicable in time of war, to search for cables away from their landing places. It is only at these places that it is possible to arrive at any results; and the recital just made shows how dangerous these operations have been.

It seems, then, that the best plan of defense would be to keep secret the tracks of the cable laid, and to conceal the landing places, instead of making them conspicuous at a great distance by towers and beacons, as is done now. It seems also that it would be easy to select the landing sights in a manner to organize a defense there, which would render the approach dangerous in time of war.

Another lesson shown by the same facts; that is, the interest that telegraphic communications present in time of war. The isolation of Cuba from Spain and from other countries was the aim towards which the efforts of the Americans were first directed in the Spanish-American war. Their first movements were made for the purpose of cutting cables; they were not entirely successful, since the cables from Jamaica remained intact. But who can say that had the Spaniards been better informed of the progress of their own operations, and of the movements of the American forces, they would not have been able to make a longer resistance?

The rôle of the cable is accentuated, then, in a manner which should engross the attention of all nations. A nation with fleets to move and colonies to defend should possess, if it wishes to keep its rank, "coaling stations and telegraph cables." This is an axiom to-day. A brief outline of the progress made by this idea among maritime and colonial powers, our neighbors and our competitors, will, perhaps, be of some interest.

If in the midst of the weighty colonial problems which trouble a part of Europe, any country ought to be safe from the anxieties which the rôle of telegraphic cables can create in time of war, assuredly England is that country. We have seen that she possesses, through her cable companies, the largest part of the telegraphic network which furrows the seas; that she has in her hands, with this network of more than 155,350 miles, a means of real dominion over the entire world.

Nevertheless, she is not yet tranquil, because certain of her cables touch in some points of their line on foreign territory. She wishes—and it is well known what the English will is—a network of cables making their landings exclusively on British territory. It is a new expansion of her imperialism, which this time she wishes to extend to the depths of the ocean. One might believe it some odd fancy, if the idea of "imperial" cables was not effectually sustained in England by personages of the first rank, and if projects had not been formed which are in process of realization.

The English government decided some months ago that a subsidy of 500,000 francs should be added by the metropolis to the subsidies, reaching 1,000,000 given by Canada and Australia for the establishment of

a trans-Pacific cable, starting from Vancouver, reaching Australia, go
by way of Fanning and Norfolk Islands, rocks almost deserted, lost
the Pacific Ocean, but *English* rocks. This cable is destined to prol
by a line exclusively British the English cables of the north Atla
and the Canadian lines. The technical study for the line is made. The e
cution will take eighteen months. Very recently, on the 19th of Octo
last, à propos of this subject, Mr. Chamberlin, exclaimed to the Ho
of Commons, that the direction of the new trans-Pacific line would
entrusted to a board of eight members, whose sittings will be held
London. The government will be represented in this board by th
members, one the president; Canada by two, Australia and New Zeal
by three. Canada has already designated Lord Aberdeen and L
Strathmore. The Australian colonies and New Zealand will be rep
sented by the General Agents of New South Wales, Victoria and N
Zealand, and negotiations are going on between the Chancellor of
Exchequer and the Postmaster-General to select the representatives
the capital. This project, endowed, as one sees, with a patronage q
governmental, forms one part of the new imperial cable, which is
make a tour of the world.

The other part has gone beyond the state of a simple project, and
already begun, which consists in the establishment of a new line st
ing from the coast of England, touching at Gibraltar, at Bathurst
Ascension and St. Helena, and finally at the Cape of Good Hope. Fr
the Cape it goes to Mauritius, where there is a coal depot, and wh
they wish also to form a great telegraphic center. Finally from M
ritius, a cable will be laid to Australia and will close the circle with wh
they wish to envelop the world. The first section of this cable has
been sunk and opened to service between the Cape and the Island
Ascension, and in a few weeks it will be extended to Bathurst.

The outlay for this second scheme, already so far advanced, will
some 125,000,000 francs, but that does not frighten our neighbors.
of the London papers says on this subject: "The sum of 125,000
francs demanded for this project would suffice to construct five bat
ships, but it must be understood that such a network of lines will o
the advantage of making every ship of war five times more powe
and more useful than it is at present." It must be supposed that a
the establishment of this great line, England will see herself somew
reassured and have a moment of tranquillity. But what a lesson
France this is, seeing that the importance of the rôle of cables in ti
of war disturbs even the country which possesses four-fifths of the t
graphic network in existence to-day.

Passing to the United States, who have just found out in pract
experience with Spain the use which one could make of cables in time
war, it can be said that to-day the same desire to assure oneself of
possession of these means of attack and defense, and the manner
which this desire is manifest, one recognizes the common sense
forethought of these people for whom colonial politics is yet quite n
There is in fact a very striking lesson in the project presented bef
Congress since the 10th of February, 1899, for the laying of a tra
Pacific cable to connect the Philippines with the United States, e
before the occupation had been made effective.

Taking action at once, the American government has already cau
to be made, even before the action of Congress, a survey by a

vessel for the location of the route of this new cable. This work is already finished.

In their debut in colonial politics the United States shows by this project the far-sighted comprehension of those necessities which have for so long a time escaped us in France. We have had colonies for centuries. For 25 years we have conquered a vast colonial empire, and the greater part of our possessions are not yet even connected telegraphically to the mother country except by the most precarious means.

Another great nation is also preparing to take a place among the colonizing nations by the laying of a submarine telegraphic cable. Germany herself, notwithstanding her geographical situation, which gives her seacoast on the North Sea only, wishes to have cables which may be independent, and assure to her the security of her telegraphic correspondence, with the United States at least. She is about to carry out a project upon which our attention might well be directed for a moment.* It is in effect of French origin and conception. It is a project which has been studied in France under the name of "Project of the Azores," and which has been abandoned. It has been taken up again to-day and is going to be realized from point to point by Germany. It consists in the establishment of new lines which will connect Germany to the Azore Archipelago, and the Azores to North America, and creating in the middle of the Atlantic, the telegraphic center that France should have herself established several years ago.

We have remarked, without doubt, the information published sometime ago by the American journals, announcing that Germany had obtained the authorization to land a cable on the coast of the United States. Equally we have read the friendly despatches which have been exchanged on this occasion between the German Emperor and President McKinley. Hence, this authorization and this exchange of telegrams had regard to this project. In 18 months, or two years at most, a trans-Atlantic cable will be laid between Germany and America, passing by the Azores. It will be established by a German company, with the support of the government, and the enterprise is placed, from the present moment, under the highest and most official of patronages. All these facts will show, if that is still necessary, the importance given in all maritime countries to the question of telegraphic cables.

It would be unjust if, after having indicated what other countries are doing, or wished to do, we passed over in silence what has been realized in France, to commence at least to guarantee our country against certain dangers.

Three years ago there only existed, as a French telegraphic enterprise, a little network of cables joining several of the Antilles among themselves and South America. Since then a single trans-Atlantic line between Brest and the United States without an assured end in America, depending consequently on the English and American companies, and almost entirely served by them.

In the course of these three last years an interesting effort has been made to break the circle of competing hostilities which have paralized, up to the present, all French enterprises of submarine telegraph.

A first cable has been established between Haiti and North America to join the lines of the Antilles to the trans-Atlantic cable which has just been landed at Brest. This trans-Atlantic cable has itself been duplicated by a new submarine line which connects Brest directly to N York. The new line is the longest which exists at present. It is m than 6000 kilometers; its construction and its laying have present exceptional difficulties, and, for its beginning, French industry has complished a daring work, to which its competitors themselves ren justice.

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* N. B.—This project has already been completed.

To-day a French telegraphic system works, with the resources of own traffic, with the development of the lines which permitted it to rea North America, all the Antilles, and South America as far as Bra This telegraphic system comprises already 23,500 kilometers of cabl It reaches the third rank in importance and extent of line, and alone, the present time, it is being developed in the face of the enorm monopoly of the English companies. Its point of attachment is Br Its employees and its direction are French, and it brings to correspo ence with our American possessions the guarantees and the securit that we claim for all our colonial possessions.

Unhappily, it is not the same for Africa, for the east and the extre east. Towards these regions our correspondence can be transmit by French lines that only reach Marseilles for the east, or to Algiers Oran for Africa. In this direction nothing has yet been underta and we have all to do.

We have seen that an active movement of ideas and projects is duced in all great maritime countries in favor of the creation of of cables. The events of the Spanish-American war have given a vig ous impulse to this movement. The more recent incidents of the with the Transvaal mark more distinctly the point of danger in allow to exist the British monopoly which weighs on all nations. Fra especially finds herself menaced and crippled if circumstances should her to sustain a war against England. The single idea that it will impossible to correspond with her colonies and with her squadrons the east and in Africa awakens a grave inquietude.

By what means can one modify this state of things? What meas is it possible to take? These questions appear to-day of a most press force. They have sprung suddenly to the front in the opinion wh surprised by the discovery of a new insufficiency in our means of fense, it is not far from accusing our public powers of want of foresi

It is useless to take up again the history of efforts made during last twenty years to produce a system of French telegraph. Except the creation of lines which connect France to the United States and American possessions, they have all lamentably failed, and furnish o one more proof of our ignorance to our own interests.

Some small cables have, however, been laid between Majunga Mozambique for Madagascar, between Noumea and Australian coast New Caledonia, between Saigon and Haiphong for Tonkin, betw the Canaries and St. Louis for Senegal; finally between Obock Perim Island for our possessions of the Red Sea. These small cab of which the most important are exploited by the English companie that we subsidized—all join the English lines and are in reality o simple annexes. We should all the more point out this situation si it is the result of a mistake which has, up to the present, domina what we are pleased to call our policy of cables, and which still hau certain minds. Simply to put off till to-morrow certain inevita charges on the budget, if one has any care for the future of the coun they have preferred half-measures, so common in France, of placing at the four quarters of the globe little ends of cables to connect certain of our colonies to the general telegraphic network. They forget that this network belongs in fact to the English companies, to whom they have intrusted even the laying and the working of certain of these cables. These, happy for the gift, receive the French subsidies and draw all the benefit of the establishment of a telegraph in the new countries which we colonize. These bits of cables, distant one from the other, without connection between themselves, are, however, a heavy charge, and give no security to our correspondence, and leaves us always tributary to the English system.

It is then an erroneous and dangerous conception of the question of cables that it consists in creating little local lines for our colonies. The true conception, that which alone can lead to practical solution, is the creation of telegraphic systems grouping our colonial possessions by regions, and connecting them to the metropolis by cables independent of the English lines. This is the only means of having cable lines which can become productive at a given moment, and constructing them in such a manner that the telegraphic traffic created by the new line shall not be turned aside for the benefit of the English lines. It is the passage of this correspondence between our colonies and France that will furnish the enumeration of the new enterprise. It was foolish to abandon it to a rival enterprise. It is also on this condition alone that we will avoid English combination, and that we will have in our own hands an agent of information and of defense which is indispensible to us, above all in a moment when we have so many interests to watch in China, Siam, Madagascar, Morocco and all of Western Africa.

It seems, moreover, that we should in the present circumstances and for the future, look at the question of cables with a courageous broadness if we wish to solve it. There exists to-day a chasm in the armament of France for the defense of its interests in the countries beyond the sea; a chasm which it is necessary to close without loss of time, if we wish to be ready for certain menacing eventualities.

It is, hence, necessary to resolve to proceed by measures united, vigorous and rapid as we have done when the lacks and the weaknesses have been proved in our armaments, in the organization of our lines of railroads, and in the construction of our ships. It is at this price that we can regain the time so uselessly lost for several years. The study and the choice of a plan of which the execution will be followed with a continuity of views and of perseverance of which the English give us every day example, will be easy at the present time, for the lessons of the Spanish-American war and of the war in the Transvaal appear to have disposed the government, and public opinion itself, to give its attention and solicitude to this side.

Neither is it a question of the government engaging directly in the expenses of establishing these networks and of burdening the budget with the whole expenses. The intervention of private initiative could furnish in France, as it has in England, the means to realize these enterprises.

Only, it should be well understood, that new telegraphic networks, having no longer the choice of rich countries to serve, must be, at first, and for several years, political instruments, established with a view of defending an interest of general order for the country; they will become

instruments of manufacture and of commerce, productive of suffic
resources to be self-supporting, only progressively, in proportion to
development of our colonies, and therefore of telegraphic traffic. O
after some years will they be able to do without the co-operation of
government. This co-operation, whether it is given under the form
subsidies as in England, or as simple guarantees, should be furnis
in the beginning, under conditions liberal enough to at least secure
capital invested. The political interest whose importance can no lon
be disputed would amply justify this. This interest is of the same nat
as that which caused the grant of postal subsidies fifty years ago. To-
the telegraph completes the mail, precedes it in all distant relations
is a means of indisputable influence, quite as much as its worthy pre
cessor, and may be called to play a rôle, active and useful, in the solut
of questions which interest our future and our defense in count
beyond the sea. Why not now admit the idea of a liberal co-operat
of the state in favor of telegraphic networks for the same reasons wh
made us inscribe the postal subsidies to the budget and keep them the

To reassure timid minds, whom the disturbances of the equilibrium
our finances may trouble, let us hasten to say that the share of
state would be probably very far from reaching the figure of the subsi
now attributed to the postal service. More than that, in place of be
permanent as the postal changes, they could be made reducible, an
disappear at the end of a fixed time, when, by the normal developmen
telegraphic communications, the network would have required assu
resources of existence. It is our good fortune that these cable li
demanded for our defense, correspond to economical and commer
needs of such importance that these needs alone would be sufficien
any country less timid than ours, to provoke their creation. The
marine telegraph is a new instrument of labor and progress, wh
enters into international life, and its application may have unlimited
velopment. It is scarcely forty years ago since the first trans-Atla
cable was open to service, and last year more than thirty millions
words were exchanged between Europe and North America. It is
possible to appreciate what the development may be in the next f
years, since its use increases every day. It will possibly reach eighty
one hundred million of words between the two continents. Fra
should make herself ready to take her legitimate share of this wonde
expansion of telegraphy. Simply from an economical point of view
is a new domain opening and inviting French activity, a domain wh
has already been explored. Great telegraphic enterprises have b
established in other countries; in England, to radiate over the en
world and to control it; in Denmark, to serve the north of Europe
Asia. All have had laborious beginnings; yet to-day they have reac
a state of powerful prosperity, shown by their annual receipts, exceed
$22,000,000 for the enterprises which have reached a normal developm

The geographical position of France, at the extremity of contine
Europe, opposite America, with the seacoasts both on the Atlantic
the Mediterranean, lends itself admirably to the creation of these en
prises. If we had a little boldness and perseverance we might have
several years ago cables joining us with our own colonies, as well
several trans-Atlantic cables, and the grand center of telegraphic
changes between Europe and the rest of the world might perhaps h
been Paris instead of London. Would there not be besides an inte

in the rôle for France to take in the movement, which is manifest to-day in all countries, to free themselves from the telegraphic monopoly of England? To destroy this monopoly, to suppress the danger of it, it is sufficient that a non-English network be created to reach all the countries where Europe possesses interests.

It might perhaps be an act of wise and far-sighted policy to associate in this enterprise, in terms reconcilable with the needs of our defense, other countries, unable to have cables of their own, but wishing to escape from the dependence in which they find themselves. The international character thus given to the new network would be its best safeguard in time of war, and if in the future these networks multiply and form in their turn a new web at the bottom of the sea, inoffensive and peaceable, the most decisive step will have been taken towards the neutralization of cables.

Assuredly here is a work for emancipation and of progress of which France ought to take the initiative, and where she would find herself faithful to her ancient and historical traditions.

THE DEVELOPMENT OF GERMAN NAVAL CONSTRUCTION.

From International Revue, September, 1900. Translated by Lieutenant H. J. Ziegemeier, U. S. N.

In all spheres of industrial activity there are revolutionary changes, in technical as well as in the economical phenomena and the condition of affairs connected therewith; but in no branch is this assertion more justified than in the methods of communication on land and sea and the different industries depending thereon.

Whilst the railroads have revolutionized the communications on land, so also has the evolution of trans-oceanic communications between different countries been put under the dominion of the steamer. The utilization of steam as a motive power created new means of communication, which gave an unheard of development to the relation between countries, which in turn gave rise to technical inventions more and more perfected. This change and perfection in the means of communication at sea, merchant and passenger steamers, gave rise to a great impetus, especially in Germany, to the industry in general, but especially in the shipbuilding yards and naval dockyards as well as in the shipping industry and in the equipment of vessels.

Towards the end of the eighteenth and at the close of the nineteenth century the principal seat of the shipping industry was located on the Baltic Sea. Not only was there a flourishing maritime commerce during these centuries, but even during the Hanseatic times had the shipbuilding industry been installed. Passing over wretched politics which regulated naval construction, it took a considerable development, thanks to the immense quantity of timber in the neighboring countries; and, as far back as the eighteenth and nineteenth century, the prohibition of exporting ships having been abolished and the construction stimulated more than ever by the payment of bounties, the shipbuilders received foreign orders of some importance.

The stagnation of an economical existence in Germany towards the close of the eighteenth century and the formidable growth of er practiced on marine construction corporations, aided by contine blockades, succeeded in severely shaking and almost in destroying industry. And, when after the reforms in the interior of the cou succeeding the wars for freedom, navigation received a new impe creating a great demand for ships, the elasticity of this industry and technical capacity which was in part checked showed itself scarcely to meet the new exigencies.

While the shipowners of the Baltic Sea were left to carry on a sp of activity by the navigation of the North Sea, especially since the ginning of emigration, and the more frequent trans-Atlantic voya the naval shipyards of the Baltic, which at other times had provi foreigners with their productions, were not able to keep up with this development.

Again the new sensations coming from England in the shape of i built ships it was affirmed with obstinacy: "Iron will not float." M over, what could be done with this antique method of building woo ships, which the son had inherited from his father, who in turn inherited it from his father, against these new mysterious constructi requiring scientific calculations as to displacement of water, stability, —and after the introduction of steam as a motive power—the loca of heavy pieces of machinery, of boilers, and the fitting up of imm spaces for coal-bunkers. In Germany there existed no means of prep tion for this technical supervision. The school of naval construct founded in 1830, at Grabow, near Stettin, had no capable professor was not until 1861, when a division of naval construction was adde the Royal Industrial Institution at Berlin, that Germany acquire school for scientifically studying this new problem; a school as had isted for a generation in England, France and Denmark. It is astonishing, then, that whilst Germany had to content herself in u ing for the marine construction of iron, the experiences gained in building of wooden ships, other countries, especially England, had immense progress, and this owing to the natural resources of coal iron, which were there side by side, and to the existence of one of oldest iron industries, with a capacity of production almost wit competition, with immense capital and a capacity of production Germany attained with difficulty after a lapse of time.

Whilst England in 1843 had constructed the Great Britain, and 1852 the Great Eastern—the new world wonder—the German shipya had only built a side-wheel steamer for service on the Elbe River, it was not until 1852 that the shipyard of Furchtenicht and Brock Bredow, later the "Stettiner Vulkan," launched their first iron ship. was only little by little that the other shipbuilding firms on the O and on the Vistula followed this example; for the fittings of a shipy required space at that time considered immense, shops complete for construction of ships, machinery, boilers, foundries, pattern shops, for and repair shops, and above all, builders scientifically and commerci perfect and with capital.

An old sailing ship from 400 to 500 tons had only cost about 50, marks, of which the hull cost about 60 per cent and the equipment per cent, including sails, cordage and English anchors; but mod ships of corresponding dimensions would cost from one to several mill marks, whilst to-day the price of the new trans-Atlantic liners reac

10, 12, and even 14 million marks, of which the hull costs about 4/10, the engines and boilers 5/10 and the equipment only 1/10.

From what precedes it is clearly seen that it was not until after 1873 that the German industry took root and prospered. Towards this time it received a great impulse by the demands for men-of-war. This proved in a way the maxim of Admiral Storch: "Without German naval construction there can be no German navy." Although already in 1869 the imperial shipyards at Kiel and Wilhelmshaven had undertaken the construction of ironclads, a number of private shipyards, "Vulkan" at Stettin, Schichau at Elbing, to which was added later "The Germania," showed an extraordinary activity in the construction of men-of-war; the good reputation of their products soon drew to the German shipyards numerous orders from foreign navies, the first of these being China. Little by little German naval construction learned to conquer all difficulties, so that in 1875 the factories at Dillingen were undertaking with success the manufacture of steel plates, so as to surpass even England in the production of mild steel. It was then also that that body of practical and theoretical engineers was formed which at the end of the century has carried German naval construction to the highest state of perfection.

This development made giant strides. German proprietors of merchantmen, who up to the present had been a little cautious and hesitating, having for a long time been in the habit of having their ships built in England, Scotland, on the Clyde, on the Tyne or on the Baltic, seeing these productions, no longer hesitated in giving their orders to German shipbuilders; especially in 1879, when the duty on all shipbuilding material was abolished, thus putting the German yards in a better state to compete in price with the English ones.

In 1882 the Hamburg-American Line ordered from "Vulkan" and from "Reicherstiegwerft" the large steamers Rugia and Rhaetia, and the "North German Lloyd Co." agreed hereafter to use only German-built vessels in their voyages in order to obtain the government subsidies.

"Vulkan," who had at the same time an order for six similar steamers, was better fitted for working on a colossal scale, having overcome the losses at first sustained, but losses which served as a lesson, and which enabled them in the future to fulfill all demands. In 1888 the first large trans-Atlantic liner, Augusta Victoria, was launched, followed soon after by the Kaiser Wilhelm der Grosse, thus being able to boast of a production which did not even have its equal in England. The construction and lengthening of three steamers to be subsidized, executed by the firm of Blohm and Voss furnished another proof that German naval construction had likewise reached perfection in the merchant marine construction.

The construction of men-of-war had made equally rapid progress, thanks to the orders for four armorclads of the Brandenburg type and the large cruiser Kaiserin Augusta. The nickel-steel plates produced by Krupp in 1894 furnished an armament that no industry outside of Germany could produce. In the construction of torpedo-boats the firm of Schichau reached a high degree of perfection. The torpedo-boat chasers constructed in 1895 for the Chinese navy attained a speed of 35.2 knots, fulfilling all anticipations.

But it was on the 10th of January, 1900, that the German marine celebrated its greatest triumph, and where it entered boldly into a new epoch; on that day the steamer Deutschland was launched; the dimensions of this vessel are: displacement, 23,000 tons; length, 202 meters. This vessel has 33,000 horse-power and is one of the fastest in the world, and capable of carrying 1320 cabin passengers.

The industrial activity has increased likewise. Owing to the immense developments in the shipyards and dry docks, Germany, which as late as 1890 was getting three-fifths of her ships from England, is in condition to build nearly all the ships for which she has need. In 1898 the importation from foreign markets had fallen off one-third. More than 16 per cent of all the new constructions were for foreign orders.

The German shipyards during 1899 furnished in all 468 ships complete, aggregating a total of 250,000 tons; one-eighth more than in 1898, without counting 250,000 tons in different stages of completion. Among these ships completed, 87 were of 500 tons and over, and 87 per cent of all being steamers. For the navy there were only 5 of this number, 6 per cent as against 18 per cent for the preceding year.

In 10 years the output of German naval construction has doubled, being in 1889, 80,000 tons steamers and 20,000 tons sailing ships.

The consumption of iron has likewise increased from 45,000 tons in 1890 to 85,500 tons in 1899.

The proportion of German shipbuilding to the entire world's output has a little more than doubled itself, being 13 per cent to-day, whilst England's proportion has fallen from 81 per cent to 75 per cent.

There are employed to-day in the German shipyards about 38,000 workmen, and adding to this number those working on the necessary accessories—steel, iron, wood, etc.—the number is about 50,000.

Outside of the three imperial shipyards there are 39 large plants for the construction of vessels, 14 stock companies and 25 private shipyards, representing an actual capital of 110 millions. Five of these shipyards are equipped for the construction of first-class men-of-war, 9 can build cruisers, 4 or 5 are in condition to undertake the construction of large trans-Atlantic liners, and 14 can construct first-class passenger ships.

Thanks to its naval construction industry, Germany is able to furnish all the means of transportation that her maritime interests may require, and this not only in a very able way, but also in a most enterprising manner, which can resist the tempests that a coming generation could stir up.

In English naval construction, on the contrary, there has been a remarkable decrease during the last three months. Whilst the total tonnage of ships launched in 1899 was 1,414,000, giving a mean of 360,000 tons for three months, during the first three months of 1900 only 245,000 tons were launched. At the beginning of the year there were 1,260,000 tons in process of construction as against 1,385,000 tons at the beginning of 1899.

The English press actually tried to find the cause of this remarkable phenomena. One particular English journal believes that the actual price of new constructions is too high to give the necessary profits to the shipowners.

To this must be added the advance in cost of coal. Nearly all the steamship companies are complaining at the price demanded for coal, and this circumstance very often offsets the other improvements produced in commercial relations.

It is quite possible that these circumstances have contributed to diminish the desire of English shipowners of having any more ships built than the actual need at present requires; but it can well be believed that there may be other reasons. Besides these unfavorable conjectures about the times, the competition which increases from year to year, and in which, as we have seen above, Germany takes so active and brilliant a part, has contributed to this decrease, which the United Kingdom has had to take notice of during the last three months.

REPORT OF THE CHIEF OF THE BUREAU OF ORDNANCE.

The report of Rear-Admiral O'Neil, Chief of the Bureau of Ordnance, states that satisfactory progress has been made in the manufacture of the new long-caliber guns with which our latest battleships and cruisers are being armed; it also shows that the important work of converting the old slow-firing weapons to rapid-fire guns is being carried through as fast as the capacity of the gun shop at Washington will allow.

During the year the last of the 13-inch guns ordered, making thirty-four in all of that caliber, has been completed, while of the twenty 12-inch guns of the new 40-caliber pattern ordered for the ships of the Maine and Arkansas class, one has been tested at the proving-grounds and has given admirable results. The test showed that this weapon is the most powerful of its type in the world, for under a powder-chamber pressure of only 16½ tons, a velocity of 2854 feet per second was developed, with an equivalent muzzle energy of 47,994 foot-tons. The power of this gun is shown by comparison with the 12-inch gun of the Iowa, which with brown powder has a muzzle velocity of 2100 foot-seconds and a muzzle energy of only 26,000 foot-tons; or with the 13-inch gun of the Kearsarge, which with smokeless powder develops an energy of some 2000 or 3000 foot-tons less than the new weapon. Our new ships of the Maine and all later types will unquestionably be armed with the most powerful 12-inch rifle in the world.

EIGHT-INCH GUN.—The mention in the report of the 8-inch nickel-steel gun, 35 calibers long, which has been fitted with a new conical breech mechanism, calls to mind the late lamented Lieutenant F. J. Haeseler, who, like the late Lieutenant Dashiell, was one of the most promising of our young ordnance officers. The breech mechanism of the 8-inch gun mentioned was designed by the former officer. The threads of the plug are continuous and wind about a conical breech block. There are no slotted-out spaces, as in the cylindrical block, and its conical form enables the block to be swung on its hinge immediately into position, a single pull of the lever closing the block, turning the plug 225°, and engaging the thread throughout its whole length. Remarkable results for velocity of fire were shown by this gun at its trial. Beginning with the gun loaded, a rate of fire was obtained of six unaimed shots per minute.

SEVEN-INCH GUN.—We note with satisfaction that a set of forgings for a 7-inch experimental gun of 45 calibers has been delivered at the naval gun factory. The call for a gun intermediate in weight and power between the 8-inch and the 6-inch is occasioned by the wonderful improvement in armor due to the introduction of the Krupp process.

Time was when the 6-inch gun was more than a match for
armor carried by the cruiser class; but to-day it is questionable
the 6-inch shell, even when fired from guns of the highest velo
have, at the ordinary fighting ranges, sufficient penetrative pow
through the Krupp plates of the modern cruiser. The 7-inch or
gun combines something of the penetrative power of the 8-i
much of the handiness of the 6-inch weapon, and we confidentl
see it adopted as one of the standard guns of the navy.

Six-inch Guns.—An experimental 6-inch gun of 46 calibers
tested, and with a chamber pressure of half a ton more than th
gun, or 17 tons to the inch, has developed a muzzle velocity
3000 feet per second. The new guns of the battleship Main
later ships are to be 50 calibers long, and this increased lengt
doubt enable them to secure the same velocity with a chamber
considerably below the specified regulation pressure. These re
if anything, more creditable than those achieved with the 12-
for the muzzle energy corresponding to 3000 foot-seconds is
foot-tons. The muzzle energy of our early 6-inch guns is only
tons, so that the introduction of its own special powder and
methods of construction have enabled our Ordnance Bureau
than double the striking energy of this caliber of weapon.

Good progress has been made with the new 50-caliber guns
4-inch and 3-inch caliber, and the present indications are that
ment of the many new vessels under construction will keep
the progress of the ships themselves.

A most valuable work of reconstruction, of which but little
is the task of converting the old slow-firing guns of the earlie
our navy to rapid-fire guns, thereby enormously increasing
ciency. During the year twenty-five 6-inch, 30 caliber guns h
converted, making a total of eighty of this class which have
improved, while four 8-inch, 30 caliber guns which were remo
the Chicago to make way for a more modern type have been fi
new and improved breech mechanism. The time is approachi
the batteries of every ship in the navy will be of the rapid-fire

As was recently mentioned in these columns, the Bureau
successful in securing satisfactory contracts for the armor req
the three battleships of the Maine class, the five battleships of t
sylvania and Virginia classes, the six armored cruisers of the W
ginia class and for the three protected cruisers of the Milwauk
It is highly gratifying to learn from the report before us that the
qualities of the Krupp plates which have been made by the Carn
Bethlehem companies for Russia show that the armor-makers
country are capable of reaching the highest standard in the man
of face-hardened armor.—*Scientific American*, Dec. 22, 1900.

THE BRITISH NAVY.

On Tuesday the official list of the ships ordered to be con
was published. It represents an addition of two battleships, six
cruisers, two second-class cruisers, and a couple of sloops, to the
navy. The battleships are the Queen, to be built at Devonport;
Prince of Wales, at Chatham. The armored cruisers are the C

to be built at Pembroke; the Suffolk, at Portsmouth. Orders for the remaining four have been given to private firms. The Berwick will be built by Beardmore & Co., Limited; the Cumberland, by the London & Glasgow Shipbuilding Company, Limited; the Donegal, by the Fairfield Shipbuilding Company, Limited; and the Lancaster, by Armstrong, Mitchell & Co., Limited. The two second-class cruisers will be built in government yards—the Challenger at Chatham and the Encounter at Devonport. The Odin and Merlin sloops will be built at Sheerness. In another page will be found detailed information about the contracts.

While we have in mind the very considerable additions to our naval strength which are being made, and particulars concerning which have already appeared in our columns, we regard the programme of construction just commenced as altogether inadequate to the requirements of the country. The British realm advances in dimensions by leaps and bounds. The growth of the population of the Queen's dominions augments rapidly. The bond between our colonies and the mother country has been drawn closer and closer. These and other considerations emphasize the responsibilities of the government; and accentuate the importance of the command of the seas. We want more ships of all kinds. It is a vain thing to dispute concerning this type or that type. We need ships of every type that is likely to be serviceable. We have no sympathy with hysterical pessimists who run about crying ruin, and denouncing our naval policy; but we have nothing to say on the other hand in favor of those who hold that our navy is quite strong enough. It could only fulfil this condition if our neighbors rested content to let their naval dockyards lie idle. Our existing navy would only suffice if the wealth of our colonies and the limits of our dominion remained fixed. The expansion of the empire must needs be accompanied by the development of the forces by which alone that empire remains ours. It is not necessary even to take count of territory added to our possessions. The increase in wealth is ample reason for the taking of unparalleled precautions to secure it. A Liverpool or a Sydney, poverty stricken, would hold out small temptations for aggression. As they are, Blucher's words when he saw London, may be remembered, "Himmel; what a city to sack!"

It seems to have been admitted by Mr. Goschen and the Government last session that additions to the navy were desirable, but that they could not be made; because, in the first place, all the government yards were full. Secondly, because private firms were too busy to accept orders. Thirdly, because armor-plates could not be had in time. The fallacy of every one of these statements has been demonstrated; at the most they represented half-truths. The precise reason why more ships were not laid down will probably remain a Whitehall secret. Various hypotheses were framed to explain Mr. Goschen's policy. It has been said that no designs for ships were ready; that the Admiralty could not make up its mind how to spend money. On another hypothesis, the ships were not ordered because there were no crews to be had to man them. Lastly, it was urged that such a dearth of officers—and particularly engineer officers—existed that it would have been quite useless to build more ships, because they could not be put in commission. It is noteworthy, however, that in all this storm of surmise and censure, no one ventured to hint that Parliament would not vote the necessary supplies. In point of fact, if an adequate programme were declared when Parliament meets, and the Admiralty asked for £10,000,000 a year for the next five years, the money would be voted without a dissenting voice, save, perhaps, the petulant wailing of the few "Little Englanders" who have found their way into Parliament, and there serve the same useful purpose as the traditional "Frightful Example" at temperance meetings. It is, however, not to be disputed that confidence in the Admiralty has been somewhat shaken; and with every desire to allow for difficulties, we are by no means certain that ten millions would be spent to the best advantage under the existing system.

There is such a thing as a paper fleet, and there are critics—competent critics too—who do not hesitate to say that there is rather too much paper about our fleets. It is useless to possess ships which cannot fight. Unfortunately not a few ships, and these among the latest additions to our navy, have been in plain phrase failures so far. While the Boiler Committee is pursuing its labors, we do not propose to criticise Belleville boilers. But committee or no committee, we cannot shut our eyes, and we do not want to shut our eyes to unpleasant facts. The Europa, a new and so-called first-class cruiser, has been disabled by one voyage to Australia and back, and is now under repair. The Hermes after a disastrous experience is now lying in Bermuda. The Pegasus was disabled after an eighteen months' commission. The Powerful is undergoing heavy repairs at Portsmouth. The difficulties with the Terrible and Highflyer no longer excite attention. The Diadem, the Argonaut, and the Arrogant have all proved unsatisfactory; and all this while our battleships with Scotch boilers keep the sea and do good service. Nor is it the boilers alone which are open to criticism. It seems to be by no means certain that the machinery is not also in fault. When we read of the enormous consumption of steam by auxiliaries, we fancy that old times have returned when six pounds of coal per indicated horse-power per hour was a thing to boast of as representing great economy. Again, it would seem that there is not a cruiser afloat which has a properly made condenser. Nor does the matter end here. In naval circles it is held that we have many fighting ships which would be wholly impossible in action; that, in fact, they would be blown to pieces in five minutes by modern vessels. Care must be taken that nothing of the kind finds its way into the new programme; and it should not be forgotten that the enormous improvement which has been effected in armor, making a 5-inch plate at least as good as one of the older kind of twice that thickness, has given the naval designer scope for providing protection in a way hitherto unknown. It may, however, be assumed that all these points will be fully considered by the Admiralty. But it is once more necessary, we think, to urge the folly of providing Belleville boilers in ever increasing numbers. The last discovery is that if only lime enough is put into them they will no longer give trouble. In a few months it will also be discovered that there is nothing at all new in the use of lime; that it may well prove a remedy worse than the disease; and that it will quickly drop out of use again. In the providing of boilers we counsel patience. It will be well to wait until the report of the committee is laid on the Admiralty table.—*The Engineer*, Nov. 2, 1900.

TURBINE STEAM ENGINES.

A discussion of some interest has recently taken place between Mr. Parsons and Mr. Thornycroft concerning the relative merits of the Viper, which has attained a speed of 36.858 knots, with turbine engines, and the Albatross, constructed by Messrs. Thornycroft & Co., which has a speed of about 31 knots. It appears that at less than full speed the turbine is not economical, and in practice it is found that while one ton of coal will take the Albatross 22.6 knots, the same quantity will take the Viper a little less than 12 knots, the speed in both cases being 15 knots. For the moment we are not concerned with that branch of the controversy which deals with the merits and demerits of these boats for fighting purposes. It may be argued that, as torpedo destroyers are after all not well fitted for cruising, one with a very high speed for a spurt must be better than the slower boat which can keep the sea longer. Our purpose now is to consider why the turbine engines should be less economical at slow than at high speeds.

In its construction the steam turbine closely resembles the water turbine. There are vanes which move and guide blades which remain at rest. It is important to bear in mind that in both these machines there is at all times a clear passage right through the wheels. There is nothing to arrest the flow of either water or steam through them. The effect of this is that if we block a water turbine so that it cannot revolve, nearly as much water will flow through it as if it was at work. If we block the revolving drums of a Parsons turbine the steam will flow through, almost as fast as if it was revolving. If we take the water turbine and examine it when blocked, with the water passing through it, it will be seen that the water leaves it at about the same velocity with which it entered it. When revolving it leaves it at a much smaller velocity. In some turbines the quantity which can be passed through the blocked wheel is actually greater than that which will pass when the wheel is working. Precisely the same statements hold good of the steam turbine. Theoretically a perfect water turbine would deliver the water at no velocity; of course, such a condition is a practical impossibility. Without touching on the mathematics of the subject, which are of small practical value for our present purpose, it may be said that there is a velocity for the rotating wheel which is better than any other velocity, higher or lower. The greater the head, the faster must the turbines run, and, broadly speaking, it may be said that the best economical result is obtained when the velocity in feet per minute of the revolving wheel is about one-half that of the water. Now, in the steam turbine there is a speed which bears a close relation to the maximum efficiency, and this speed is very high. In order to make the facts clear, we may use a simple illustration. Let us suppose a number of balls to fall from a height on a movable inclined plane. The balls move vertically. If, now, the inclined plane is drawn back, base first, sufficiently fast, the balls will continue to move vertically, and will exert no pressure on the plane. If, on the other hand, the plane is held fast, then the balls will exert an effort on the plane, tending to drive it back, and they will themselves be deflected toward the toe of the plane and will roll down it. The problem is to take as much as can be taken out of the balls in the shape of the driving effect on the plane; and to this end the plane must move at a speed which bears a definite relation to its angle of inclination and the paths of the balls. We may with strict propriety consider that steam as made up of myriads of little balls moving at a very high velocity, and the inclined planes, or their equivalent the vanes of the Parsons turbine, must also move at a very high velocity in order that the *vis viva* of the steam may be transformed into torque energy with the least waste. In the steam dynamo there is a constant reversal of the direction of the current, but with this we need not further concern ourselves. In any case, the steam must escape with some remaining velocity and momentum, and this is waste. If the machine runs too slowly, steam will to all intents and purposes pass through it without doing any work. On the other hand, if it runs too fast, the steam will again flow through it without doing any work. We come back to the starting point. There is a velocity which is better than any other, and, indeed, so much better that any departure from it is productive of great loss of efficiency. As the speed depends on the velocity with which the steam moves, it may be thought that by reducing the pressure of the steam, and thereby its velocity, less power can be got without loss. This is no doubt true to a certain extent; but it cannot do much in practice, because the velocity of flow of steam does not vary directly as the pressure, but as given by the formula, $v = 3.5953\sqrt{h}$, where $v =$ the velocity of outflow in feet per minute for steam of the initial density, and h the height in feet of a column of steam necessary to give the pressure. To illustrate the bearing of this formula on the question discussed, we may say that, according to Brownlees' classical experiments, while steam of an absolute pressure of 30 lbs. on the square inch flows into the atmosphere at a velocity of 1401 feet per second, steam of 100 lbs. pressure has a velocity of 1459 feet per second. From which it will be gathered that the speed at which a turbine is most efficient is very little affected by the boiler pressure. In other words, the low-pressure turbine will have to run nearly as fast as the high-pressure turbine. Certain conditions modifying this come into play, no doubt, but the fact remains unaltered, that any considerable departure from the speed of maximum efficiency results in a greatly increased consumption of steam. This is one principal difference between the engine built by Mr. Parsons and that made by Mr. Thornycroft. Lastly, in this connection we may say that the comparatively moderate consumption of steam in the Parsons engine—20 lbs. or so per brake horse-power per hour—is due to the way in which the steam is used, because of which initial condensation is reduced to a very small amount. In a word, steam remains steam in the Parsons engine to a greater extent than it does in the reciprocating engine.

So far we have only dealt with the turbine engine as an engine. We have now to consider its efficiency when combined with a screw propeller. It will be readily understood from what we have said that the velocity of the moving vanes in feet per second must be very high. In the United States many patents have been taken out for engines in which a moderate speed of rotation is combined with a high angular velocity of vane, by making the diameter of the wheel large. But this cannot be done in torpedo destroyers with moderate draught, say 7 feet. The result is that the rate of rotation of the screws reaches 2500 to 3000 revolutions per minute. The compulsory result is that the pitch of the screw must be extremely fine. But a fine pitch always means that the surface velocity of the screw must be very high if the boat's speed is high; and another direct consequence is that the loss of power due to the surface friction in the water of the propeller is great. Here, again, we have the peculiar case of a certain velocity of maximum efficiency, to say nothing about cavitation or a cutting of a partial vacuum, so to speak, in the water. We have a speed, and surface, and pitch, which are better than any others; and it is admitted very readily by Mr. Parsons that the surface or blade area of screw which is correct for the maximum speed of boat is much too large for low speeds. It is well known that for all steamships there is a speed of engines and ships which is more economical than any other speed, but with reciprocating engines running at moderate speeds—anywhere, that is to say, between 60 revolutions for a tramp and 300 revolutions for a torpedo destroyer, there are wide margins, variations within which will very little affect the result. Thus, for example, a torpedo destroyer running at 10 knots, will probably burn less coal per horse per hour than will be used when she is running at 20 nots, and a good deal less than when she is running at 30 knots, but even then the differences are not large. With the turbine, however, the case is different. With such a boat as the Viper it is all or nothing. At extreme speed she may beat the reciprocating engine also at extreme speed in steam consumption per horse per hour; but at any other speed the turbine loses, and at half-speed or thereabouts economy goes to pieces. Not only is the engine wrong, but the propellers are wrong. We do not for a moment contend that this fact is one greatly to the detriment of the turbine engine. Nothing of the kind. The only effect that a fixed and extremely contracted relation between speed and economical efficiency has is that it narrows the limits of application of the turbine engine. Such an engine, for example, might be in every way satisfactory for steamers running between Dover and Calais; Holyhead and Dublin, or even between Liverpool and New York, while they would be wholly unfit for a man-of-war. In the first cases the speeds are always the maximum practically possible, and there would be no difficulty in designing engines to suit. In the navy the speeds are wholly various, and for various speeds the turbine steam engine is not suited. It must not be forgotten, again, that in a large vessel there would be room for turbines of considerable diameter, and so the velocity of rotation of the screw might be fairly moderate. All things considered, we think it by no means improbable that the turbine steam engine will be largely adopted in the mercantile marine for special high-speed services of the ferry type, such as the Atlantic passenger trade, but for warships it is wholly unsuited, the success of the Viper to the contrary notwithstanding, because she is not a warship.—*The Engineer*, Oct. 26, 1900.

MARCONI'S LATEST DEVELOPMENTS—SYNCHRONIZED MESSAGES.

At the annual gathering of the British Association for the Advancement of Science, in 1899, Prof. Fleming of University College, London, addressed the gathering upon Wireless Telegraphy, and incidentally mentioned that while transmitting messages from Boulogne to Dover they were read at Chelmsford, some 118 miles from the point of transmission. This, undoubtedly, was a remarkable performance, but it also emphasized very forcibly one drawback which has long occupied the unremitting attention of Marconi. That is, the possibility of one or more stations reading a message intended for another. Such a circumstance naturally destroys the privacy of the message, and although it is not a very significant matter in the ordinary way, yet it would be a very serious drawback, in case of war, for one belligerent to be able to intercept to read a message that was being transmitted between the vessels o other belligerent. Marconi quickly realized the serious nature of disadvantage, and at his station at Poole, in Dorsetshire, Englanc has been endeavoring for a long time past to successfully synchro his messages; that is, to construct a transmitter, the message from w can only be received by the apparatus which has been tuned to receiv

He has successfully solved the problem, by means of variable ductors and capacities, by the use of which certain instruments can receive certain messages. By his latest system, Marconi can disp from a certain point any number of messages, and each message wi received only by that receiver that has been synchronized to the tr mitter, so that jamming of words and confusion of messages upon various receivers are obviated.

Marconi has set up his station at Poole because that place is so rer and he is safe from interruption. Twenty odd miles away across Solent is another station at the southwestern corner of the Isle of Wi Between these two points messages are being transmitted througl the day, almost without cessation, and this is how several important coveries and improvements have been made by the inventor. W experimenting with his synchronizing system, Marconi had several op tunities of proving the capabilities of his device. At Portsmouth English Admiralty were carrying out experiments with wireless te raphy in connection with the fleet, and naturally several of these e waves crossed Marconi's line of transmission between Poole and Isle of Wight, the effects of which upon his instruments the inve regarded with the utmost satisfaction, since they proved that he finally surmounted the most perplexing disadvantage of his system.

Marconi has also made some other important discoveries. He utilizes cylindrical tin cans, about five feet in height, in lieu of the ver wires, since they furnish more convenient capacities and radiators. is lengthening the distance over which messages may be transmitted, although his experiments at Poole can be conducted only on a lim scale, yet he is confident that when he works upon a larger station will be equally successful, and there is no doubt but that many impor developments in ether telegraphy will be divulged in the near future

At the present moment Marconi has a sufficiency of work on h The North German Lloyd Steamship Company are having one of systems installed at Berkum (Germany), to be used in connection their fleet of vessels. Apropos of this, Marconi has been carrying many experiments with a view to applying the system practically shipping, so that greater safety may be assured to vessels at sea. T the International Company of France are having the coast of country, metaphorically speaking, lined with his installations, so communication may be maintained between the vessels of the Fre navy and any point of the mainland, which would play an important in case of a war between England and France, since by this means latter nation could manipulate their troops according to the informa received from their battleships, and thus be able to work the land sea forces hand in hand. Then six stations are being set up in Hawaiian Islands and will soon be in working order. Many vessel the English navy are also having the system installed.—*Scientific Ameri* Sept. 8, 1900.

NAVAL CONSTRUCTION IN FRANCE.

The constructions to be carried out by the French government during 1901 comprise 111 vessels, and among these figure the battleship Iena, which is already in service, and is only down on the programme to account for a balance to be paid next year. Two submarine boats, the Français and Algerien, are completed, and will shortly be launched, and three squadron and six coast-defense torpedo-boats will also soon be finished, so that they cannot properly be included in the programme for 1901. Excluding these, there are four battleships, fifteen armored cruisers, a first-class cruiser, twenty-four destroyers, fifteen submarine boats, seven squadron torpedo-boats, thirty-two torpedo-boats, and the unfortunate aviso-transport above mentioned. Of the battleships, the Henri IV and the Suffren, which have been built at Cherbourg and Brest respectively, have been launched, and their armaments will be completed six months hence. Two other battleships will be put on the stocks as soon as the grant voted by the Chamber is ratified by the Senate. One is to be constructed at Brest and the other in a private shipyard. These will be another addition to the multifarious types already existing in the French navy, and were proposed by the Commission of the Marine and introduced by the Minister, who was strongly supported by the naval deputies. The Chamber had so long shown an uncompromising antagonism to battleships, that the approval of the government scheme was a victory for the old school. Each of the battleships will have a displacement of 14,865 tons, and the engines will develop 14,475 horse-power. The maximum speed is to be 18 knots, and steaming at 10 knots the ships will have a range of action of 8930 miles. The armament will be composed of four heavy guns, eighteen guns of medium caliber, and twenty-eight small guns, as well as five torpedo-tubes. Of the fifteen armored cruisers, fourteen are on the stocks, and the Jeanne d'Arc, of 11,270 tons, will be entirely completed next year. The Montcalm, now building at La Seyne, will also be finished in 1901. This vessel has a displacement of 9517 tons—the same as the Gueydon and Dupetit-Thouars, which will be launched in 1902. Five other armored cruisers, the Marseillaise, Gloire, Condé, Amiral Aube, and Sully, have each a displacement of 10,014 tons. The two first named will be finished in 1902, and the others in the following year. The Desaix, Dupleix and Kléber, each of 7700 tons, are built partly of wood, and are intended for service in the tropics. All three will be launched in 1902. The Léon Gambetta and Jules Ferry are new types of armored cruisers, with a displacement of 12,550 tons and with engines of 27,500 horse-power, and are expected to attain a speed of 22 knots. These vessels were put on the stocks this year. Two others of the same type will start building at Toulon next year. The Jurien-de-la-Gravière is a protected cruiser of a type which has been abandoned.

The government has given up the construction of small torpedo-boats, but is turning its attention to boats of a larger tonnage, as well as destroyers, which form an important factor of the new programme. Fourteen destroyers are on the stocks, and ten others will be started upon next year. So far all the destroyers have been built in private yards, but Rochefort is beginning to give a great deal of attention to them, and orders for ten destroyers have recently been placed at the government shipyard. Three of these will be completed next year, and the remainder in 1902. Rochefort is to receive orders for two n destroyers. Two others have been put on the stocks at Havre this ye and fourteen are to be ordered from private shipbuilders. The destroy are taking the place of the squadron torpedo-boats, which are found lack sufficient sea-going qualities, and it is not likely that any more be built after the seven now under construction at Havre and Bordea have been delivered. Three others mentioned in the programme already completed. Of the thirty-eight first-class torpedo-boats, two building at Cherbourg, two at Toulon, and two at Saigon. Private ya have already delivered eleven boats, including a turbine boat, the Lib lule, and have ten under construction, while eleven others will be put the stocks next year. In submarine boats the French navy is not lik to belie its traditions with respect to multiplicity of types, for in its ha to get a submarine fleet the government orders vessels of any type wh seems to give fairly satisfactory results. The process of weeding doubtless take place later on, when experience has shown what exactly the limitations of the new boat, and under what conditions it c reasonably be expected to be of service. Seventeen submarine bo are provided for in the programme, and eight others will probably ordered next year, these being all constructed in the government sh yards. All these vessels are more or less experimental, and French na critics are by no means satisfied yet as to their efficiency.—*The Engine* Oct. 19, 1900.

ARMOR-PLATE TRIALS.

It is perhaps scarcely necessary to state that it has always been difficult matter, even under old conditions, to meet the high standa armor-plate requirements of the British Admiralty; but since the adve of Krupp armor the task of meeting requirements has been render still more severe. To enable them successfully to overcome these di culties, Sir W. G. Armstrong, Whitworth & Co., have from time to ti carried out various experiments on lines laid down by themselves wi the object of producing armor-plates of the highest quality. Early in the year they were in a position to submit to the Admiralty two 6-in plates, produced at their Manchester works by a special process of th own. On July 3 these plates were placed under official preliminary tri at the government testing station on Whale Island, Portsmouth. The plates were of the normal size for trial purposes, viz., 8 feet by 6 feet a 6 inches thick, and were installed in the frames provided in the proof ce Resistance and Thundered. The trials were conducted under the sup intendence of Captain W. H. May, of the Excellent, and Lieutenant S. Drury-Lowe, R. N., whilst the Admiralty was represented by Lieutena G. P. Hope, for the Director of Naval Ordnance, and Mr. W. E. Smi for the Constructors' Department. Mr. Saxton Noble (Director) w also present on behalf of Elswick, and Mr. J. M. Gledhill for the Ope shaw works. Five shots were fired at each plate with Holtzer arm piercing shell at the velocities laid down for this thickness of plate cemented steel. Both plates defeated all the projectiles, and were pr nounced as satisfying in every respect the service requirements.

The table given is copied from the official report of he trials. *The Engineer*, Oct. 5, 1900.

ARMOR PLATE TRIALS. REPORT ON ARMSTRONG, WHITWORTH, AND CO.'S 6 IN. PLATE, TESTED AT WHALE ISLAND ON JULY 3, 1900.

Thickness of plate, 6 in. Rounds fired, five. Backing, thickness, top and bottom, 3 ft. 9 in.; centre, 3 ft. 8½ in. Secured by eight bolts.

Round.	Gun used.	Weight of projectile.	Point of striking.	Effect on front of plate.	Effect of striking on projectile.	Remarks.
1	6 in. Q. F.	Holtzer, 100½ lb.	2 ft. from right edge, 2 ft. from bottom.	Penetration, depth 2¾ in.; size of injury 19½ in. × 18½ in.	Projectile broken up	Striking velocity 1998 f. s., energy 2768 foot-tons.
2	"	Holtzer, 100 lb.	2 ft. from left edge and 2 ft. from bottom.	Penetration, depth 2⅝ in.; size of injury 23¼ in. × 14 in. Slight surface crack towards right edge. Piece of projectile of round 1 jarred out.	" "	Striking velocity 1974 f. s., energy 2702 foot-tons.
3	"	" "	2 ft. from left edge and 2 ft. from top.	Penetration, depth 2½ in.; size of injury (1) 12⅞ in. × 11½ in. (2) 23¼ in. × 18¾ in. Further scaling and surface crack to left edge, developed in round 2. Further scaling.	" "	Striking velocity 1970 f. s., energy 2691 foot-tons.
4	"	" "	2 ft. from right edge and 2 ft. from top.	Penetration, depth 2⅝ in.; size of injury (1) 12 in. × 11 in. (2) 20¼ in. × 18¾ in. Plate slightly bulged. Further scaling on round 3.	" "	Striking velocity 2024 f. s., energy 2841 foot-tons.
5	"	" "	3 ft. from right edge, 4 ft. from bottom.	Penetration, depth 2¼ in.; size of injury 21⅝ in. × 18½ in. Surface crack upwards to left upper corner towards No. 3.	" "	Striking velocity 2047 f. s., energy 2804 foot-tons.

THE COMPARATIVE EFFICIENCY OF THE KRUPP, ARMSTRONG AND SCHNEIDER-CANET GUNS.

In determining the relative efficiency of modern guns there are many elements to be taken into consideration, particularly in the case of weapons which are intended for naval service, where velocities are usually much higher than those common in weapons for field service. A comparison of relative efficiency must take note of all ballistic features. As a matter of fact, the methods of designation used are apt to be misleading, for the reason that they make too much of certain elements of efficiency, and too little of others. Thus, we find that, popularly speaking, it has become the fashion to quote the muzzle velocity of a gun in preference to any other of its ballistic capibilities. If the public hears that a gun of a certain caliber is capable of a muzzle velocity of 3000 feet per second, as against velocities of 2600 or 2800 feet per second in other guns of the same caliber, it is apt to consider that the high-velocity weapon is incontestably the most effective. This superiority, however, by no means follows; for the mere statement of the muzzle velocity, unaccompanied by any statement of the weight of the shell to which such velocity is imparted, conveys no information as to the actual hitting power of the gun. Then again the relative efficiency may further be modified by a statement of the weight of the gun itself, for it is evident again that if two guns, one of which is considerably lighter than the other, show the same muzzle energy, the lighter gun is ton for ton a much more effective weapon. A further modification is introduced when the question of the "remaining velocity and energy" is introduced; for although a light projectile, issuing from the muzzle of a gun at an extremely high velocity, may have the same muzzle energy as a heavier projectile with a lower muzzle velocity, the lighter projectile will lose its velocity far more rapidly as the range is covered, and what is known as the "remaining velocity and energy" of the heavier shell will be relatively greater, the greater the distance that is covered. It is mainly for this reason that many of our naval officers regret to see the 13-inch guns displaced by the 12-inch, the hitting power of the 13-inch shell at long ranges being considerably greater than that of the lighter 12-inch shell.

In determining upon the armament of their navy, the Germans have evidently been governed by this consideration; for it is a fact that the Krupp guns, with which their ships are armed, fire projectiles which are considerably heavier for any given size of gun than those used in any other navy. Although the muzzle velocities given in the ballistic tables of these guns are not so high as those of other nations, the muzzle energies are greater and the "remaining energies" are in some cases enormously so. Just how great is this difference is shown in an article which we publish in the current issue of the *Supplement*, which contains a series of graphical comparisons of the relative ballistic energies of the Krupp guns and those of the great firms of Armstrong and Schneider-Canet.

Thus, in comparing the velocities and energies of the Krupp 9½-inch gun with the Armstrong weapon of the same caliber, we find that, although the muzzle velocity of the Armstrong projectile is 762 meters per second, as against 729 meters per second for the Krupp gun, at 1750 meters from the muzzle the velocities are equal, and at 5000 meters the

Krupp has a remaining velocity of 491 meters, as against a remaining velocity for the Armstrong shell of only 448 meters per second. The loss of velocity is due to the fact that the Armstrong projectile, weighing only 159.7 kilogrammes, as against 218 kilogrammes for the Krupp projectile, is more influenced by the resistance of the air, and therefore loses its velocity more quickly. Although the velocity of the Armstrong weapon is 33 meters greater than that of the Krupp gun, its muzzle energy is 1098 meter-tons smaller, and at a range of 5000 meters its energy is still 1012 meter-tons less. Judging the two guns on the basis of the amount of energy developed per kilogramme of weight of gun, we find that at the muzzle it is for the Armstrong 176.8 meter-kilogrammes per kilogramme of weight of gun, and that in the Krupp weapon it is 214.4 meter-kilogrammes per kilogramme of the weight of the gun.

Comparing the guns on the basis of their armor-piercing ability, it is shown that while the Krupp 9½-inch rapid-fire gun can perforate 30 centimeters of Harveyized armor up to 3100 meters range, an Armstrong gun of the same caliber, in spite of its greater velocity, can do this only up to 1250 meters. Harveyized armor 25 centimeters thick is perforated by the Krupp gun up to 4500 meters, by the Armstrong gun only up to 2400 meters, while the Schneider-Canet 9½-inch gun cannot perforate that thickness at a range of over 2000 meters.

Although a strong case is made out for the superiority of the Krupp guns along the lines referred to, there is one drawback to the use of the heavier projectiles which must not be lost sight of. We refer to the fact that the greater weight of the shell will reduce the total number of rounds that can be carried for each gun; a consideration which is of importance where every ton of the displacement of a ship is valuable when it comes to the question of distribution among the contending claims of armor, engines, stores and ammunition. Furthermore, the increased weight must tell somewhat against the rapidity of handling; and if the ammunition is to be handled at the same speed, it becomes necessary to install heavier machinery for operating the hoists.—*Scientific American*, Dec. 1, 1900.

THE NEW 12-INCH NAVAL GUN.

The new 40-caliber, 12-inch gun, the first lot of which will be mounted on the new monitors and on the Maine class of battleships, and which will henceforth be the standard weapon of this caliber for our navy, has been completed and tested at the Naval Proving Grounds, Indian Head; about twenty rounds having thus far been fired.

With a charge of 360 pounds of smokeless powder, and a projectile weighing 850 pounds, a muzzle velocity of 2854 foot-seconds was obtained with a corresponding muzzle energy of 47,994 foot-tons, the chamber pressure being 16½ tons per square inch, or a half ton less than the designed working pressure of 17 tons. We are informed that the gun, its mechanism and mount functioned admirably in every respect. The Bureau of Ordnance is to be congratulated in having achieved such admirable results.

The fact that this gun shows 54 foot-seconds greater velocity than it was designed for, with half a ton to the square inch less pressure in the powder chamber, speaks volumes for the excellence of the multiperforated, all-guncotton smokeless powder which has been adopted by the navy; for unlike the high nitroglycerine powders, such as cordite, which are used by some other nations, our new navy powder achieves these splendid results without any perceptible deterioration of the inner surface of the gun.

It is interesting to compare the new weapon with the 12-inch 35-caliber guns now in service. The new gun weighs 53.7 tons and has a muzzle energy of 893 foot-tons per ton of gun. The present 12-inch gun, which weighs 45.2 tons, has a muzzle velocity with smokeless powder of 2300 foot-seconds, and the corresponding muzzle energy of 31,170 foot-tons amounts to only 689 foot-tons per ton weight of the gun. From the above comparison it will be seen that the muzzle energy of the new 12-inch gun exceeds that of the old by 53 per cent.

COMPARISON OF 12-INCH, 40-CALIBER NAVAL GUNS.

	Weight in tons of gun.	Weight in pounds of projectile.	Muzzle velocity feet per second.	Muzzle energy in foot-tons.	Foot-tons energy per ton of gun.
United States, Naval	53.7	850	2,854	47,994	893
German, Krupp	48.9	981	2,592	45,662	934
British, Vickers	50.3	850	2,600	39,843	792
British, Armstrong	50.8	850	2,580	39,233	772
British, Naval	50.0	850	2,481	36,290	726
French, Naval	45.9	644	2,625	30,750	670
12-INCH GUNS OF 35 AND 50-CALIBER.					
*United States Naval, 35-caliber	45.2	850	2,300	31,170	689
Krupp, 50-caliber	62.4	981	2,953	58,205	934
Krupp, 50-caliber	62 4	771	3,330	58,205	934

* Old pattern as used on Iowa.

If the energy developed by one round of the new gun could be applied as a constant upward thrust beneath a 12,000-ton battleship, it would be sufficient to raise it 4 feet from the ground.

The excellence of this weapon is shown by a comparison with other 40-caliber, 12-inch guns, which are being constructed by the leading gun makers of the world. At the bottom of the list is the French gun, which in spite of its high velocity, shows a muzzle energy of only 30,750 foot-tons the relatively small energy being due to the very light shell, which weighs only 644 pounds. The inferiority of this gun is greater than appears on the surface figures; for the lightness of the shell will cause the velocity of the projectile to fall away far more rapidly than that of the heavier projectiles. We should note in this connection that although the muzzle velocity of the Krupp 40-caliber gun is lower than that of the new United States gun, because of the greater weight of its shell, it will approach it in respect of its remaining energies at the longer ranges. Judged by the muzzle velocity and muzzle energy, the new United States weapon stands easily first; but judged by the standard of energy per ton weight of the gun, it will be seen that the Krupp weapon has a considerable lead. It would be interesting, in this connection, to note how Krupp obtains these results with a gun so comparatively light in weight. It is possible that this gun is constructed of nickel-steel, and that an abnormally high chamber pressure is allowed.

Following the table of the 40-caliber guns are placed three guns of 35 and 50 calibers, the first being the type of 12-inch gun at present in use in our navy, and the 50-caliber guns being two of the 1899 Krupp models, which the company state have actually been manufactured and tested with the results herewith shown. The enormous energy of 58,205 foot-tons is obtained in the first of these two weapons with a 981-pound projectile having a muzzle velocity of 2953 foot-seconds, and in the second by a 771-pound projectile driven at 3330 foot-seconds velocity, the energy of 934 foot-tons per ton weight of gun being, as far as we know, the greatest efficiency yet obtained with any gun, experimental or otherwise. As this gun is over 50 feet long, however, it is altogether too unwieldly for service on shipboard, at least according to the present accepted ideas on the subject.—*Scientific American*, Dec. 15, 1900.

INTERESTING EXPERIMENTS WITH TORPEDOES.

Some elaborate experiments to test the explosive force of torpedoes have recently been carried out on an uninhabited island in the Trans Sound, an inlet of the Gulf of Finland. The officials in charge of the trials erected a galvanized hut. In this they placed a torpedo-tube charged with a Whitehead torpedo, the nose of which projected from the tube, as it would if placed on board ship in time of war. The idea of this particular test was to ascertain what would occur if a shot was to penetrate the torpedo-tube on board a battleship while charged with a torpedo. With a view also of obtaining some idea of what effect such an explosion would have on the members of the crew, a number of sheep was permitted to graze in the vicinity of the hut. The air in the air chamber of the tube was compressed to eighty atmospheres. The shot, fired from a safe distance, penetrated the wall of the hut and entered the air chamber of the tube. No explosion resulted, but the imprisoned air rushed through the hole caused by the bullet with a terrific noise, but no damage was caused. The next experiment was to explode 187 pounds of guncotton inside the hut near the head of the torpedo protruding from the tube. The explosion was effected by means of a twenty minutes' time-fuse, so that the officials might have sufficient opportunity to get away from the spot. Some of the officers took up positions upon a small neighboring island. The sheep, as before, were grazing around the hut. The guncotton exploded with a terrific report, and no doubt also fired the

charge within the torpedo, since the tube, shed and the sheep near
blown to pieces.

Strange to say, a sheep seventy-five yards from the hut was absolu
uninjured, thus proving that the force of the explosion was local.
officers who watched the operations from the neighboring island ex
ienced a severe concussion of air. The officials now procured a pont
which they had covered upon the bottom surface with four thicknesse
armor-plate. This was placed in shallow water and a torpedo was f
from a tube so as to strike the protected bottom of the pontoon.
result of the impact was that the pontoon was blown into the ai
Scientific American, Oct. 27, 1900.

GATHMANN AERIAL TORPEDO GUN.

An American contemporary has given us some striking figures a
results obtained by the big Gathmann aerial torpedo gun constructed
Bethlehem, which is shortly to be tested by the Board of Ordnance,
which General Miles is president. This weapon is 18 inches in calib
and is 44 feet in length, yet it weighs only 59 tons. The exterior dime
sions so closely resemble those of the 12-inch gun that it can be mount
on the 12-inch gun-carriage. The weight of the torpedo shell is 1
lbs., and it carries 625 lbs. of wet guncotton. The muzzle velocity
about 2200 feet per second when fired with Gathmann's smokeless powd
Engravings accompany the statements, showing, first, an armor-pla
after being struck by three 12-inch projectiles, by which it appears th
the plate is practically uninjured; and, secondly, the *débris* of the enti
structure plate and backing after the impact of a single Gathmann she
Mr. Gathmann has been the best part of twelve years developing th
gun, and the writer remarks that if the piece " will do half what its adv
cates claim for it, the ingenuity of man will be severely taxed to inve
some system of defense that will successfully resist it."

We agree with the writer in this conclusion, but we think that the "i
should be written very large indeed. Some months ago we spoke of
large-caliber gun being constructed at Bethlehem under the direction
Lieut. Meigs, which, carrying a large explosive at a moderate velocit
might, we thought, for many purposes be a most valuable gun, but
never committed ourselves to such statements and figures as those giv
above. Without going into actual calculation here, it will be appare
that the above are beset with difficulties. To begin with the gun, it
of the same external dimensions as the 12-inch piece, which is only tw
thirds of its caliber. This implies a very light thin breech, for doubtle
the breech only is contemplated, and we certainly do not want to increa
the difficulties presented to us. It would be supposed that this must
a low velocity gun, yet 2200 foot-seconds cannot even now be called
low velocity. Then the torpedo shell weighs 1800 lbs., as against t
2000 lbs. of the 17-inch 100-ton gun. The cubes of 18 and 17 are near
in the proportion of 8 to 7, so that this means that the torpedo 18-in
shell is very much slighter, taking the weight into account—almost
quarter less—solid and strong, even supposing it to be of somewh
similar form. Seeing that it contains 620 lbs. of wet guncotton, howeve
it must be a projectile of very great length, and consequently its stru
tural strength must be slight indeed, and for the attack of armor pra

tically useless. Wet guncotton is here spoken of as if it almost was a new substance, yet about ten years ago we reviewed results obtained by German artillery against land works with wet guncotton shells, this substance being at that time preferred by Germans to melinite and other high explosives. The effect of these shells was then found to be very great indeed. But mark what follows. General Brialemont then concluded—and we had the opportunity of hearing it from his own lips—that armored defenses were called for to defeat these destructive shells. The fact is that up to the present time explosives have only destroyed armor when carried well into it by a shell with some penetrating power. We admit that we do not know of so large a charge as 620 lbs. being employed, but that armor can be successfully attacked by a very weak shell containing even such a charge has to be shown. Present evidence is against it. Observe that the projectile never strikes direct on service, and the oblique breaking of such a projectile is a very much enfeebled affair. We will, however, go further; we have yet to be shown that the projectile will shoot. Without fully working it out, we can see that it has much against it, and is likely to fail just where all these mammoth explosive torpedo shells have hitherto failed—that is to fail in hitting the mark. The Vesuvius had nothing to prevent her proving the powers of her torpedo shells at Cuba, yet the official Spanish report was that the effect would have been terrible had the shell fallen "near a fort." A fort is a big enough object, and yet all efforts failed to lodge a shell even "near" one. It is never wise to ridicule the possibility of a design being good because inflated accounts are given of it. In this instance we think the accounts decidedly inflated, but what we think may be important as a solid residuum is what we wrote in the spring, namely, that under many conditions in warfare it may answer well to sacrifice high velocity for the sake of a shell carrying a large explosive charge for the attack of weaker structures. We have no evidence to indicate success in the attack of heavy armor. If this 18-inch gun is treated soberly it may, we think, have a future.—*The Engineer*, Aug. 24, 1900.

THE NEW FIRST-CLASS AUSTRIAN COAST-DEFENSE BATTLESHIP HABSBURG.

The new Austrian battleship which is now in the course of construction at the wharves of the Stabilimento Tecnico Triestino, and which is to bear the name Habsburg, is the first of a series of ships authorized by the Austro-Hungarian government. The Habsburg is a coast-defense vessel of 8340 tons displacement, 354 feet in length and 65 feet 9 inches in beam. She will draw 23 feet, will have engines of 11,000 indicated horsepower, which will drive her at a speed of 18 knots. The armor will consist of a belt of chrome-nickel steel 8.6 inches thick, extending four-fifths of the ship's length. The gun positions are protected by 8.2 inches of armor plating. The deck plating is composed of 2½-inch steel. The armament will be composed of three 9.4-inch rapid-fire guns, mounted in turrets, two forward and one aft; twelve 5.9-inch rapid-firing guns, mounted in two superposed rows so that four guns can be directed aft, four forward and six to each side; and twenty-four smaller guns of various sizes.—*Scientific American Supplement*, Nov. 10, 1900.

DUTCH TORPEDO-BOAT HYDRA.

The Hydra is one of two similar boats, the other being the Scylla. They are intended to strengthen the naval power of the Dutch authorities in their East Indian colonies. The boats are 130 feet long, 13 feet 6 inches beam, and have a displacement of about 90 tons. The contract speed is 23 knots. The machinery consists of a set of triple-expansion engines designed to indicate 1200 horse-power. The special feature of these engines, and in which they differ from those of other torpedo-boats, is the system of forced lubrication which has been adopted, the working parts of the engine being completely enclosed. This plan has been introduced with great success in many types of land engines, and is becoming a feature of modern high-speed engines in small sizes. The great advantage of forced lubrication is that all anxiety on the part of the engineering staff is set at rest as regards this the most important point in the proper working of such fast-running machinery. The auxiliaries include a centrifugal circulating pump with its engine for supplying the condenser with water, an evaporator and distilling plant in duplicate; steam steering engine and air compressor; dynamo for electric lighting; an overhead fan and fan engine in the stokehold between the two boilers for forced draft; also a Worthington pumping engine in the stokehold for feeding the boilers when the main engines are not working. The bunkers hold about 18 tons of coal. The armament consists of three 18-inch swivel torpedo-tubes and two 6-pounder quick-firing guns.

The official trial of the Hydra took place on May 25. A mean speed of 24.37 knots was made for the three hours with 160 lbs. of steam, and a trifle over 400 revolutions per minute, the load carried being 17½ tons.

The official trial of the Scylla took place on June 26, with practically the same results.—*Marine Engineering*, Oct., 1900.

H. M. S. ESSEX.

The four armored cruisers of the Essex class—Essex, Kent, Bedford and Monmouth—although a good deal heavier than the Bayan and Prinz Heinrich, with which we have recently dealt, are, for reasons stated in a recent number of *The Engineer*, to be regarded as of the same class.

The principal particulars of the type are as follows: Displacement, 9800 tons; length, 440 feet; beam, 66 feet; draught, mean, 24½ feet. Armament: fourteen 6-inch, 45 caliber; ten 12-pounders; three 3-pounders; and an indefinite number of Maxims, probably eight; torpedo-tubes, two 18-inch submerged.

In the arrangement of her guns the Essex closely resembles the Renown, and bears much the same ratio to the big armored cruisers of the Drake and Cressy classes that the Renown bears to the Majestic class, the only striking difference is that the Essex has the high forecastle common to all our cruisers now-a-days, and that the 12-pounder battery amidships is open as in the Duncan. As for these differences, the high forecastle is absolutely indispensable to a swift cruiser. Earlier cruisers, like the Blake and Edgar classes, suffer a good deal in bad weather from the sea they take in forward; the effect of which is noticeable in two vessels of the class—Crescent and Royal Arthur, which had their forecastles built up to improve their steaming qualities in bad weather.

The more or less open upper decks is, we believe, the result of a report sent in by Captain H. J. May, R. N., who pointed out that the high bulwarks in the Majestic, and later types up to the Duncan, would simply burst shells in the worst possible place, *i. e.*, just in front of men at the guns. We referred to this important question in our "Dockyard Notes" some months ago. The compromise in the Essex design falls a good deal short of Captain May's ideal—which was to have the 12-pounders absolutely unencumbered by boats, davits, stanchions, or anything else—still it is a vast improvement upon the older idea of high bulwarks. Not, however, that the high bulwarks must be dismissed as a mere thoughtless excrescence, for they serve at least two distinct uses. In the first place, many men are put to sleep on this deck in ships thus fitted—in the Essex this would not be possible owing to the low sides; in the second place, there is a theory, now pretty well established and proved, that men shoot better when they have the sense of protection—fallacious though this protection be—that these high bulwarks afford.

To resume the description of the Essex. The 6-inch guns are thus disposed: Two in a turret forward, two in a turret aft, six on the main deck amidships, and four on the upper deck above the forward and after main-deck guns. All these pieces are in armored casemates.

Six 12-pounders are on the upper deck amidships, two under the forecastle forward, two on the main deck right aft.

This is the armament of the Essex in the original design. The usual rumors about a change in her armament are now given currency, chiefly connected with the 7¾-inch quick-firer, which rumor has mounted in most of our new ships. Much mystery attaches to this gun, which was first spoken of in connection with the four last cruisers of the Diadem class. It is worthy of note, too, that the four upper-deck casemates in these ships are very large, and apparently designed to take such a gun. Possibly we are waiting for a foreign lead—as usual. In general, naval officers are mostly far from admirers of the cruiser carrying nothing but 6-inch guns. There is a feeling that 9.2 guns are wanted in the Diadem class, which, though much larger than the Elswick cruisers of the Asama type, carry fewer guns and no armor worth mentioning. The same thing applies to some extent to the Essex, as will be seen from the comparisons below:

	Essex class.	Asama class.	Diadem class.
Displacement	9,800	9,750	11,000
Horse-power	22,000	19,000	16,500 (18,000 in some)
Speed, knots	23	22	20.25
Main armament	—	Four 8 in.	—
Secondary armament	Fourteen 6 in.	Fourteen 6 in.	Sixteen 6 in.
Tertiary armament	Ten 3 in.	Twelve 3 in.	Fourteen 3 in.
Submerged tubes	Two	Four	Two
Armor deck	(?)	2½ in.	4 in.
Armor belt, amidships	4 in.	7 in.	—
" ends	2 in.	3½ in.	—
" lower deck	4 in.	5 in.	—
Turrets and bases	5 in.	6 in.	—
Casemates	4 in.	6 in.	6 in.
Coal, normal	(?)	550	1,000
Coal, Maximum	(?)	1,300	2,000

It should be noted that all fourteen 6-inch guns are protected in the Essex, in both the Asama and Diadem four 6-inch guns only have shields.

It may be observed that the Diadem class pay heavily in speed, guns and armor for the few hundred tons of coal extra that they carry, and to see their superiority over the Asama class needs a good deal of optimism. Nor, since the Diadem carries no guns capable of penetrating the Elswick cruiser's armor, is it quite clear how she could do her much harm.

The armor of the Essex is thin and extensive. There is a belt about 250 feet long amidships, of 4-inch Krupp cemented armor, and this belt extends right up to the main deck. It is continued to the bow at a thickness of 2 inches. Aft it is terminated by a 5-inch bulkhead. A curved protective deck runs throughout the length of the ship and reinforces the water-line protection. The space above and below is filled, as usual, with coal-bunkers. The casemates are 4 inches thick, the turrets 5 inches, but for these nickel armor, not Krupp, is employed. It has less resisting power, but is more easily worked. There is said to be great difficulty in using Krupp armor for circular or nearly circular turrets. These turrets have short armored bases of 5 inches thickness, with armored hoists going down the main deck.

The turrets are distinctive and, so far, peculiar to the Essex class. To begin with, the guns in each can be trained together and fired as one piece or else used independently. These guns, their mountings, and so forth, are to be furnished by Vickers, Sons & Maxim, Limited, who have brought out the design. Many details seem to be as yet provisionally decided on only, or were so a short time ago, pending exhaustive experiments. There is a single hoist to the pair of guns, worked by an electric motor. It serves with very great rapidity, and when in full working order delivers every alternate charge to the port gun, which has a special small motor to catch it as it comes up the endless chain. This arrangement can be easily disconnected—the hoist is then made to serve one gun only. This is merely a rough general description of a—for the British navy—absolutely novel form of hoist. It is, presumably for that reason, so far " strictly confidential "—but gunnery officers generally are very pleased with it. It remains to be added that three layers of projectiles are carried in the turret underneath the guns, which can be loaded in any position or elevation. Double hoists, adapted from the same system will, it is said, be fitted to the two-story casemates.

The Essex will have the usual rig for modern British cruisers, a searchlight platform on each top, but no fighting-tops for guns. There will be three funnels. The engines are designed to give 23 knots with 22,000 horse-power. The boilers will be Belleville of the latest pattern, fitted with economizers. We may now proceed to compare the Essex class with the Russian Bayan and the German Prinz Heinrich, the ships with which—bearing in mind that the British custom of building ships 20 per cent or so heavier than foreign ones—they are intended to be on the same level. The difference is not entirely a matter of more coal, spare gear and more ammunition; indeed there is probably far less gain in these things than is generally assumed. This gain seldom seems to match the additional tonnage, and we fancy that the main point of difference should be looked for in increased habitability and seaworthiness, both points that, though they make small show on paper, would, in a war lasting a year or so, probably be more important than an extra gun or two. In the glib comparisons between British and foreign ships that are so often made now-a-days there is a curious ignoring of this very vital point. However, it is hardly one that can be reduced to statistics.

In the following comparison we omit any reference to the dimensions, and the tonnages are given chiefly as a general index. The powers of offense and defense are those upon which we chiefly desire to concentrate attention:

	Essex.	Bayan.	P. Heinrich.
Displacement	9,800	7,800	8,868
Horse-power	22,000	17,000	15,000
Speed (maximum), knots	23	21	20
Main armament	Nil	Two 8 in.	Two 9.4 in.
Secondary armament	Fourteen 6 in.	Eight 6 in.	Ten 6 in.
Tertiary " (protected)	Nil	Eight 3 in.	Nil
Tertiary " (unprotected)	Ten 3 in.	Twelve 3 in.	Nil
Small pieces	Three 3-pdrs. and Maxims.	Seven 3-pdrs.	Ten 1-pdrs. four Maxims.
Submerged tubes	Two	Two	Three
Above-water tubes	Nil	Three (2 protected)	One
Armor belt (amidships)	4 in.	8 in.	4 in.
Armor belt (bow)	2 in.	4 in.	3 in.
Lower-deck armour	4 in.	3 in.	4 in.
Protection to main armament	—	7 in. on each turret; 3 in. hoists to these.	6 in.
Protection to secondary armament	Four 6 in. in turrets with 5 in. armour. Ten 6 in. in casements. with 4 in. armour.	3 in. on three redoubts.	6 in. on turrets and redoubt.*
Protection to tertiary armament	Nil	3 in. on eight of them.	Nil

Nothing definite has appeared as yet concerning the coal supply of either the Essex or the Prinz Heinrich, so comparisons as to what the bigger ships may gain in this particular are not possible. But the Bayan is stated to be designed to carry no less than 750 tons normally, and 1100 tons maximum capacity. These figures, however, may not be above reproach. Coal supply, too, is now-a-days becoming one of those items that are much juggled with, and "normal coal supply" may mean more than one thing. In theory it is the coal carried at the nominal displacement, but the nominal displacement is often very nominal. British ships, too, whatever they may displace, invariably carry what is known as the "maximum capacity." All our big battleships and cruisers of the Diadem class take in up to 2000 tons as a matter of course, though this is, on paper, assumed to be a sort of emergency amount. The Elswick cruisers built for foreign powers have never to our knowledge loaded with the "normal" amount; they usually take a mean between that and the "maximum capacity." The lines of British designs admit of this without much, if any, effect on the speed; the lines of some foreign ships certainly will not so easily permit of it. In dealing with coal capacities, therefore, we generally have to deal with a certain amount of the unknown.

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* It is not certain whether this redoubt will be more than 4 in. thick—some German service papers call it 6 in., others 4 in. The turrets are certainly all of them 6 in. thick, and have been manufactured by Krupp.

Taking these three ships and comparing them, we find that if we arrange them according to their superiority in speed, armament and armor, we get—

Speed.	Offence.	Defence.
Essex.	Prinz Heinrich.	Essex.
Bayan.	{ Essex.	Prinz Heinrich.
Prinz Heinrich.	{ Bayan.	Bayan.

This is very approximate. The only comment to make is that it is highly improbable that the Russians will ever make the Bayan steam so fast as the German ship, in service, the engineering department being the weak point of the Russian navy. On the other hand, our engineers and the Germans are very good.

In offense the Prinz Heinrich is unquestionably first. She is the only ship of the three able to deliver a vital blow. The Essex is sacrificed to a fad about 6-inch guns in this respect.

In defense, the Bayan lacks from, in our opinion, an unnecessary thickness of her belt. She has a protection to her vitals as good or better than that of many battleships. Above, she is not shell-proof. Otherwise, had she had a, say 5-inch belt, and 5-inch, or whatever the equivalent may be, on the redoubts, her defense would have been as good or better than any. We hold that of the Essex better than the Prinz Heinrich's because she does not risk, like that ship, having all her 6-inch put out of action by one big shot.

It is an interesting subject to speculate on, but such speculations must be extremely approximate. The Essex is probably designed with the prime idea of speed, the others with different objects, so that we should be rash indeed to attempt to lay down which is the better ship of the three. What we do chiefly feel is that there is a good deal of room for some ships of both the Prinz Heinrich and Bayan types in our navy—the Bayan especially, as we have nothing at all like her, whereas the Cressy assimilates to the Prinz Heinrich in the matter of carrying armor-piercing guns.—*The Engineer*, Oct. 12, 1900.

BRITISH ARMORED CRUISER ABOUKIR.

A fine example of an armored cruiser of a type now building for the British navy is H. M. S. Aboukir, recently launched from the Fairfield yard at Govan on the Clyde. This vessel is a first-class steel, sheathed, armored cruiser of these dimensions: Length, 445 feet; beam, 69 feet 6 inches; mean draft, 26 feet 3 inches; displacement, about 12,000 tons. The Aboukir will be fitted with twin screws driven by triple-expansion engines, with cylinders 36 inches, 59 inches, and (two) 68 inches diameter, and 4-foot stroke, of 21,000 collective horse-power. Steam will be furnished by thirty Belleville water-tube boilers fitted with economizers arranged in four groups, each group fitted in a separate water-tight compartment. The boiler pressure will be 300 lbs., reduced at the engines to 250 lbs. The estimated speed is 21 knots. For protection the Aboukir will have an armor-belt of 6-inch nickel steel for 230 feet of her length and 11 feet 6 inches deep. Harveyized steel 12 inches thick will be used for the conning-tower, and the barbettes will be protected with 6-inch armor. Bulkheads will be of 5-inch nickel steel, and the protective deck will have a maximum thickness of 3 inches. The armament will include two 9.2-inch and twelve 6-inch guns, also fourteen 12-pounders, besides several boat, field, machine and automatic guns. There will be two 18-inch submerged torpedo-tubes, fitted broadside. The complement is 750 officers and men.—*Marine Engineering*, Oct., 1900.

THE ARMORED CRUISER JEANNE D'ARC.

The Jeanne d'Arc, which was successfully launched at Toulon on the 8th of June, belongs to the class of armored cruisers, and is in every respect superior to many of the vessels of this type which still figure upon the lists of modern fleets. Her armor is composed of plates of Harveyized steel, the force of resistance of which is much greater than that of the iron plates which protect very many of the armorclads now in service. Her guns, which are of unusual power, are very efficient, as a consequence of the progress made in the manufacture of ordnance. Finally, the Jeanne d'Arc is a very swift vessel, and made 23 knots on her trial trip, say a little more than 25 miles an hour. Perhaps it will be regretted that an attempt has been made to obtain so great a speed, since this has certainly rendered it necessary to sacrifice many things and to surmount great difficulties, by reason of the immense space required by the engines and boilers that are always required in such a case.

This cruiser is not designed to form part of a squadron for war duty, but has a more modest mission, that of protecting maritime commerce, making raids in distant seas, and destroying the enemy's merchant vessels and swift packet boats. In order to do this a vessel must have a high speed, a sufficiently high-power armament, and a wide radius of action, which is equivalent to saying that its coal supply must permit it to make long trips. To solve such a problem is not easy. Whether the Jeanne d'Arc will solve it, it remains for the future to say.

The armored cruiser is in great favor in all navies, and is now taking the place so long occupied by what are called protected cruisers, that is to say, those that are destitute of side armor. About twenty years ago the English constructed a group of five of these, but went no further in this direction. France, in turn, took up the work and produced an excellent ship, the Dupuy de Lôme, which embodies most of the innovations that are now in general use. The Dupuy de Lôme was an admirable vessel, and it would have been necessary only to increase her size in order to improve the type. Her armor was a very prominent feature, and the artillery in turrets was perfectly protected; but the French waver in their ideas, and, instead of improving upon this specimen and giving a wider range of action, they reduced the tonnage, the protection, the speed, and the armament of the vessels that followed. This error led them to add to their navy five inadequate armored cruisers of about 5000 tons, which are neither fleet ships nor ships for a squadron and which are now utilized in any way that may be found possible. With the Jeanne d'Arc, France has taken a new departure and is now constructing twelve cruisers, some of 10,014 tons and others of 9500 and 7700, with a speed of 21 knots.

The Jeanne d'Arc has the following dimensions: Length over feet; breadth, 63.75 feet; mean draught, 24.75 feet; displacement tons.

She has two groups of three funnels, two protected conning-tow two masts. The foremost is provided with a military top equipp 1½-inch rapid-fire guns, designed to repel the attacks of torpedo The other mast is to be used only for signals.

The vessel has three screws, each driven by triple-expansion engines, each of which is completely isolated and independent neighbors. This is the Depuy de Lôme system, now applied first time upon this vessel.

Steam is furnished to the cruiser's engines by tubular boilers Guyot type, and belonging to the general type of what are called tubular or aqua-tubular generators, and the water in which through the interior of the tubes. The evaporating apparatus furnish 28,500 horse-power, although a portion of this will be util running the numerous—too numerous—auxiliary engines that upon the vessel. The modern ship is truly a huge workshop, in the mechanic reigns as master.

For feeding the grates, it is possible to stow away upon the d'Arc 2100 tons of coal. This supply, increased by several hundr of petroleum, will permit of running 4000 leagues at sea at the low of 10 knots; and so the Jeanne d'Arc will be able easily to make to China without a stoppage. In order to protect her, there ha established, according to the French system, an armored belt for steel plates of 6-inch thickness that surround the entire loadwat and, above this, a thinner protected belt of 3-inch thickness. the armor ascends toward the front, almost for a third of the starting from the stem, thins down to 2¼ inches, and covers the height of the hull. Such an arrangement has been devised becau swift cruiser the front is the part that is most exposed to the fire enemy. The protection is completed by two armored decks.

Let us now pass to the ordnance. The armament is compo follows: Two 7.6-inch guns in turrets; eight 5.6-inch guns in cas or in sponsons; twelve 4-inch guns in turrets; sixteen 1.6-inch gun the bridges; eight 1.3-inch guns upon the upper deck and in the m top; and two submerged torpedo-tubes. The turrets for the 7.6-in 4-inch guns are closed and protected with steel, as are also the cas and sponsons. The small pieces are sheltered behind shields of ha steel.

By reason of this distribution of her artillery, the Jeanne d'Arc p three fine lines of fire: the first consisting of her 7.6- and 4-inch g turrets; the second of her 5.6-inch guns in protected casemates; a third, dominating all, of her small 1.6- and 1.3-inch pieces.

Such is the armored cruiser Jeanne d'Arc, which embodies ever gress that has been made in the naval art, and in which electricity a leading rôle both for the driving of machines and external and in lighting. Let us add that the vessel will cost a little more than t one million francs. According to the Navy Department, she will available for service until toward the end of the year 1901.

For the above particulars we are indebted to *La Nature.—Sc American Supplement,* Nov. 17, 1900.

THE NEW GERMAN CRUISER AMAZONE.

The Amazone is a third-class cruiser of the vedette sort, equivalent to our own Pelorus class. She is spoken of and to some extent is an improved Gefion, but, as the following particulars show, she resembles the prototype in little save armament:

	Gefion.	Amazone.
Displacement, tons	4207	2645
Length, feet	334	328
Beam, feet	42½	39
Draft, feet...............	21½	16⅓
Armor deck, amidships. ..	3 in.	2 in.
" ends	1 in.	1 in.
Armament	Ten 4 in., six 6-pdr., eight machine.	Ten 4 in., ten 3-pdr., eight machine.
Torpedo tubes............	Two above water.	One submerged, two above water.
Horse-power, maximum...	9828	6600
Speed (maximum), knots..	20.5	20
Coal (normal), tons.......	900	300

The Gefion was launched in 1893; it is interesting, therefore, to note that German ideas, which in the Gefion closely followed ours, have since then branched off in an entirely independent direction. In the Gefion coal is the chief consideration, and the guns are secondary. In the Amazone it is just the other way about. The most she can carry is 500 tons.

However, before discussing the ship at length, it may be interesting to compare her with our similar ships, the Pelorus class. In the connection the Russian Novik, with which we shall be dealing in an early number, may also be introduced, as she represents the same kind of sacrifice as the Amazone, only in her case everything is sacrificed for speed:

	Amazone (German).	Pelorus (British).	Novik (Russian).
Displacement, tons	2645	2135	3000
Length, feet	328	300	361
Beam, feet..............	39	36½	39⅓
Draft, feet..............	16⅓	15*	19
Guns....................	Ten 4 in., ten 3-pdr., eight Maxims.	Eight 4 in., eight 3-pdr., three Maxims.	Six 4.7 in., eight 3-pdr.
Torpedo tubes, submerged	1	0	0
" above water	2	2	6
Armor deck, maximum..	2 in.	2 in.	2 in.
Horse-power............	6000	7000	17,000
Speed (maximum), knots.	20	20	25
Coal (normal), tons......	300	250	(?)
Coal (full capacity), tons.	500	500	(?)

As the Pelorus is a much smaller ship, her coal supply is proportionately better, nor does she in any way compare badly with the German. It is worthy of note that the Pelorus has 7000 indicated horse-power to make her speed with, while the larger German has to do it with less. Sisters of the Amazone have done their 20 knots on trial, but in a race the honors would undoubtedly go to the Pelorus class.

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* 15 ft. is the Pelorus' nominal draft, but 17 ft. is probably nearer the actual. The 19 ft. extreme draft to the Novik is doubtful.

To return to describing the Amazone. It will be noted that her gu
as in most German types, are placed with a great regard for end-on fire
the theoretical right-ahead fire being four guns, while the amidship piec
have a very large arc. The Pelorus has but two guns that fire rig
ahead. Actually the German fire would not exceed three—cases in whi
both end sponsons could fire at the same ship being chiefly theoretic

The Amazone is to be fitted with the Schultz boiler, which is an adap
tion of the Thornycroft, and resembles it very closely indeed.

The protective deck has a somewhat curious form, various hatchwa
in it being protected with armored coamings. Amidships, too, the de
instead of being a mere roof to the engine-room, more or less fits clos
upon them, and wherever anything reaches high up the deck is th
domed up for it. It is at least ingenious. Altogether about eight sh
of the Amazone type are built or building. Those launched and co
pleted or nearly so include the Gazelle, Nymphe and Niobe. Another,
Ariadne, has just been launched. The remaining three are not named
yet. Others appear to be projected.—*The Engineer*, Nov. 2, 1900.

THE GERMAN ARMORED CRUISER PRINZ HEINRICH.

The Prinz Heinrich, at present completing for sea, is apparently
tended as a standard type for German armored cruisers. Unlike
Fürst Bismark, she is not a merely weak battleship, but a cruiser pure a
simple, built chiefly with an eye to cruiser work.

Her principal dimensions, etc., are as follows:

Displacement	8868 tons.
Length	394 ft.
Beam	65½ ft.
Draft (mean)	23¾ ft.
Armament	Two 9.4 in. (24 cm.).
"	Ten 6 in. (15 cm.).
"	Ten 1-pounders.
"	Four Maxims.
Torpedo tubes	One bow, submerged.
" "	Two broadside, submerg
" "	One, stern, above water

The armor is distributed as follows: There is a complete water-l
belt of Krupp armor 4 inches to 3 inches in thickness, reinforced b
protective deck 2¾ inches thick on the slopes. Above the belt there i
redoubt about 165 feet long, and of about the same thickness as the b
Above this again is the main deck redoubt, 6 inches thick, in which
of the 6-inch guns are mounted. Both redoubts have 6-inch bulkhea
while screens will be placed between the guns in the upper one. On
of the upper redoubts there will be four turrets, oval in shape, eac
inches thick, and carrying a 6-inch gun. Forward and aft are barbet
each mounting a single 9.4-inch gun, and protected by stout shie
These barbettes will have a total height of about 9 feet, will be 6 inc
thick, with armored hoists descending to the protective deck.
conning-tower, which will have a thickness of 6 inches or more, will h
an armored tube of communication.

It will be noted that the Prinz Heinrich has little in common with

Fürst Bismark. The latter has no protection to the lower deck, and has her armament a good deal more distributed. The Prinz Heinrich, on the other hand, is a direct adaptation of the French Brennus, and closely resembles that ship both in the disposition of armament and in the system of armoring. The high forecastle and the bow submerged tube are the only distinctly German features in the design, and there is nothing of the Fürst Bismark about her save in general outline.

Like all German ships, the Prinz Heinrich will have no wood used in her construction, unless the latest discovery, or supposed discovery, that woodless ships are very insanitary, causes some departure from a well-established German custom.

The estimated indicated horse-power is 15,000, which is expected to give a speed of 20 knots. There are three screws, and the deadwood aft is very much cut away after the Elswick model, in order to make the ship relatively handy. This, for a cruiser, she should be, as she has a very fair proportion of beam to length. The boilers selected for her are of the Dürr type.

Comparisons between the Prinz Heinrich and other vessels like her in size and *métier*—the Bayan and the British Essex class—we defer till we have treated this last; but it may be of some interest to compare the Prinz Heinrich of 1900 with the Edgar class of 1890 and the Orlando of 1896, since the armaments in each case are practically identical, though the German 9.4-inch gun is, of course, a far more powerful gun than the old 9.2-inch in the other ships. This, however, is more an accident of date than anything else, and in so far as the modern guns are all heavier, enforces rather than detracts from the point we wish to make—the difference between what was demanded then and now for a ship carrying a more or less standard armament for a first-class cruiser in the way of protection and speed.

	Orlando.	Edgar.	Blake.	P. Heinrich.
Date of launch	1886	1890	1891	1900
Displacement, tons	5700	7700	9000	8868
Length, feet	300	360	375	394
Beam, feet	66	60	65	65½
Draft, feet	26	26	27½	24¾ (mean)
Armor belt, inches	10	Nil	Nil	4
Do., lower deck, inches	Nil	Nil	Nil	4
Do., battery, Q. F., inches.	Nil	6 in. on 4 guns.	6 in. on 4 guns.	6
Do., big guns, inches	4½ in. shields.	4½ in. shields.	4½ in. shields.	6
Do., deck, inches	3	5	5	2¾
I. H. P. *circa*	9000	10,000 to 12,000	20,000	15,000
Speed, trial	18.6 to 19	19.5 to 20	21.5	20 (est.)
Actual sea-speed at a push.	15.5 or less.	19.5	20.5	—

The Orlando, the only cruiser carrying belt armor except the Prinz Heinrich, has less than this ship, and is altogether smaller. She belongs to the era of "paper" ships, and to this day, with her 10-inch "armor belt"—all under the water-line, by the way—and heavy armament, is a grand ship for the makers of statistics. The Prinz Heinrich could probably tackle three of her. The Edgar and Blake are more interesting comparisons. All the class are as good ships as ever were built for speed. Although now nearly ten years old, they are all excellent steamers, and in the recent maneuvers kept station at 19 knots without the least difficult Ten years have seen far less advance in speed than people are prone imagine. It is exceedingly doubtful whether there is a warship in th world that could beat the Edgar class in a thirty hours' race. Th advance of recent years has been in protection, and the problem to-day to pile on armor without deteriorating the other cruiser essentials. O course the difference has to be made up somehow. In the case of th Prinz Heinrich coal is probably sacrificed—though, as her capacity ha not yet been announced, it is difficult to speak definitely on this poin The greatest point of divergence, however, tends to be in form, an owing to changed lines more speed is got out of a unit of horse-powe to-day than in the past. Still this embraces a wide subject hardly to b discussed in this article, the matter being very complicated. As regard its practical results, mere dimensions of the ordinary sort do not go fo much. Though the modern cruiser is, as a general rule, longer an proportionately narrower than her predecessors, we now and again fin some of the best steamers short, broad ships, comparatively speakin Of modern cruisers of moderate size nothing in the British navy ha beaten the Vindictive class, and these are only 320 feet long, with breadth of 57½ feet, dimensions very equivalent to those of the Orland class, displacement and horse-power being also fairly akin. Yet in th one case the ships never could steam fast, while in the other 19 knots easily maintained at sea in moderately smooth water. Under-water line and arrangement of weights—both things too elusive for statistics—ar of course, far and away the principal governing factors in these instance

However, length is the thing that tells directly the sea gets up, and i a seaway the Prinz Heinrich ought to beat any of the older vessels wit which we have compared her, about 400 feet being the necessary min mum of length for any cruiser to maintain speed in big waves. If she much less than 400 feet long she will be going up and down on sing waves, and lose speed accordingly. This fact—that ships cannot maintai speed unless long, coupled with the fact that they cannot steer proper unless relatively short—is one of the worst problems that faces th designers of warships. They cannot eat their cake and have it too; henc much variety and the eternal compromise. But since the present tren of ideas is that a speed-keeping cruiser is better than a handy one, mor or less long vessels are now the order of the day. Ten years hence th "agile" cruisers may be in favor again, but at the present time cruise maneuver about as adroitly as elephants.—*The Engineer*, Sept. 21, 1900.

THE JAPANESE BATTLESHIP MIKASA.

Perhaps the most interesting feature in the design of the Mikasa, th Japanese battleship launched by Messrs. Vickers, Sons & Maxim, Limite at Barrow-in-Furness, on Thursday of last week, is in the distribution her armor, several modifications in recent practice having been made the design. In giving a brief description we, therefore, give first co sideration to this. As in the two earlier Japanese battleships built this country, the Asahi and Hatsuse, the water-line armor belt exten from end to end, instead of terminating at the ends of the citadel, an thereby leaving about 80 feet from the stern unprotected. The ma belt has a width of 7 feet 9 inches, of which 5 feet 3 inches is below th water-line. The main belt armor in the way of the citadel, for 156 feet in length, is 9 inches in thickness, beyond this at either end—to some distance past the forward and aft 12-inch armored transverse bulkheads—it is 7 inches in thickness, assisted by additional 1½-inch nickel-steel plates placed on the slope of the protective deck, so as to make the resistance equivalent to 9-inch Krupp-Harveyed armor, for the whole length of the citadel and barbettes. From the ends of this 7-inch belt to the ends of the ship the armor is 5½ inches and 4 inches in thickness. Athwartship bulkhead of 6-inch armor is fitted at the after extremity of the water-line belt to afford protection against raking shot. On the advice of the Vickers Company, the Japanese government, with their characteristic progressive tendency, have introduced in the Mikasa a departure which must be of interest to all naval constructors, the effect being to increase the area of the armored broadside. Above the main armor, and extending for the whole length of the citadel, there is 6-inch armor up to the level of the upper deck, instead of to the main deck as in previous ships, so that the total width is 21 feet 6 inches for the length of the citadel, and 7 feet 9 inches forward and abaft it.

The two barbettes are 14 inches in thickness, reduced to 10 inches where protected by 6-inch citadel armor; while the guns are protected by armored shields. The conning-tower is of 14-inch armor, the screens being 12 inches. The whole of the armor, it is almost needless to say, is constructed on the Krupp principle, and is of a nickel-steel alloy.

The extension of the main belt to the upper, instead of to the main, deck as in preceding ships, dispenses with the necessity for casemates for the 6-inch guns on the main deck; but to insure the same measure of isolation for the ten 6-inch quick-firing guns placed on this deck, as is obtained by the casemate system, bulkheads are placed between the guns, while an armored screen extends the whole length of the citadel behind the guns. These divisional bulkheads and the armored screen are of hardened steel—sufficient to insure that the splinters of any shell which may explode in one compartment will not affect either the gun or gunners in the adjoining compartment. The 6-inch guns on the upper deck, four in number, are within 6-inch casemates.

The protective deck is of a minimum thickness of 2 inches, and extends over the full length of the ship; but is increased to 3 inches on the sloping parts within the citadel, and to 4½ inches in thickness in the wake of the barbettes as before mentioned. In addition to this, the upper deck within the citadel is made of 1-inch plates. As usual, there is an ammunition passage under the protective deck with communication, through ammunition tubes, to the various gun positions; while coal-bunkers are arranged above and below the protective deck from end to end of the citadel. There is thus an increased broadside protection to the citadel, as well as in the ends of the ship.

The general dimensions of the Mikasa do not differ materially from those of the British battleships of recent type. The ships of the Majestic and Canopus class were 390 feet long; the Formidable, 400 feet long; and the Duncan 405 feet long—all between perpendiculars. The Mikasa is 400 feet, the length over all being 432 feet. The breadth moulded is 76 feet in the Mikasa, as compared with 75 feet 6 inches in the Duncan, and 75 feet in the Formidable and Majestic. The draft is 27 feet 2 inches, and at this the displacement will be about 15,200 tons.

Like the two preceding ships for the Japanese navy built in this country

—the Asahi and the Hatsuse—the Mikasa carries four 12-inch bre
loading guns fitted in pairs in the two barbettes on the upper deck,
fourteen 6-inch quick-firers, four placed, as already indicated, w
casemates situated on the upper deck at the corners of the citadel,
remaining ten 6-inch guns being placed in the box batteries on the
deck. The auxiliary armament of the ships consists of twenty 12-pou
quick-firing guns, four firing ahead and four astern, the remainder b
on the broadsides; eight 3-pounder quick-firing guns and four 2½-pou
quick-firing guns. There are four submerged torpedo-tubes, two in
forward part of the ship and two aft.

The general appearance of the battleship is indicated by the elev
which we publish, and it need only be added that in her electric and
pressed air equipment she embodies the best modern practice, the li
ing installation including 900 incandescent lamps, with masthead,
anchor and other special lights and also six searchlights. The ship
be fitted as a flagship, accommodation being provided for an admiral
78 officers, the total complement being 935 all told.

The Mikasa is to have a speed of 18 knots under natural draught,
will have a coal capacity of 1400 tons, to give her a radius of actio
9000 sea miles at 10 knots speed. The engines are of the triple-expan
3-cylinder type, the diameters of the cylinders being 31 inches, 50 in
and 82 inches respectively, the stroke being 48 inches; and it is an
pated that the full power of 15,000 indicated horse-power will be de
oped with the engines running at 120 revolutions per minute, the st
pressure at the engines being 250 lbs., and at the boilers 300 lbs. St
enson link motion is adopted for working the valves, which are of
piston type on the high-pressure and intermediate cylinders, and of
double-ported flat design on the low-pressure cylinders. The engines
with all warships now, are designed to run the propellers inwards w
going ahead, so that the starting platform is in the center of the s
and here, as is now the universal practice, wrought-steel columns f
the front supports of the cylinders which are independent castings.
back supports of the cylinders are of the ordinary cast-iron A-fram
with ample slipper guide surface. The condensers are separate,
placed in the wings of the ship. The total cooling surface is 16,014 sq
feet.

The bedplate is of cast steel. The working parts of the engine g
erally are of forged steel, but the crankshaft is of nickel steel, the th
parts being interchangeable. The external diameter is 16¼ inches,
an 8¼-inch hole. The propeller shaft is of wrought steel 16½ inche
diameter, with 8½-inch hole, while the propellers have four blades,
diameter being 17 feet, and the mean pitch 18 feet. The four blades
the boss are of manganese bronze.

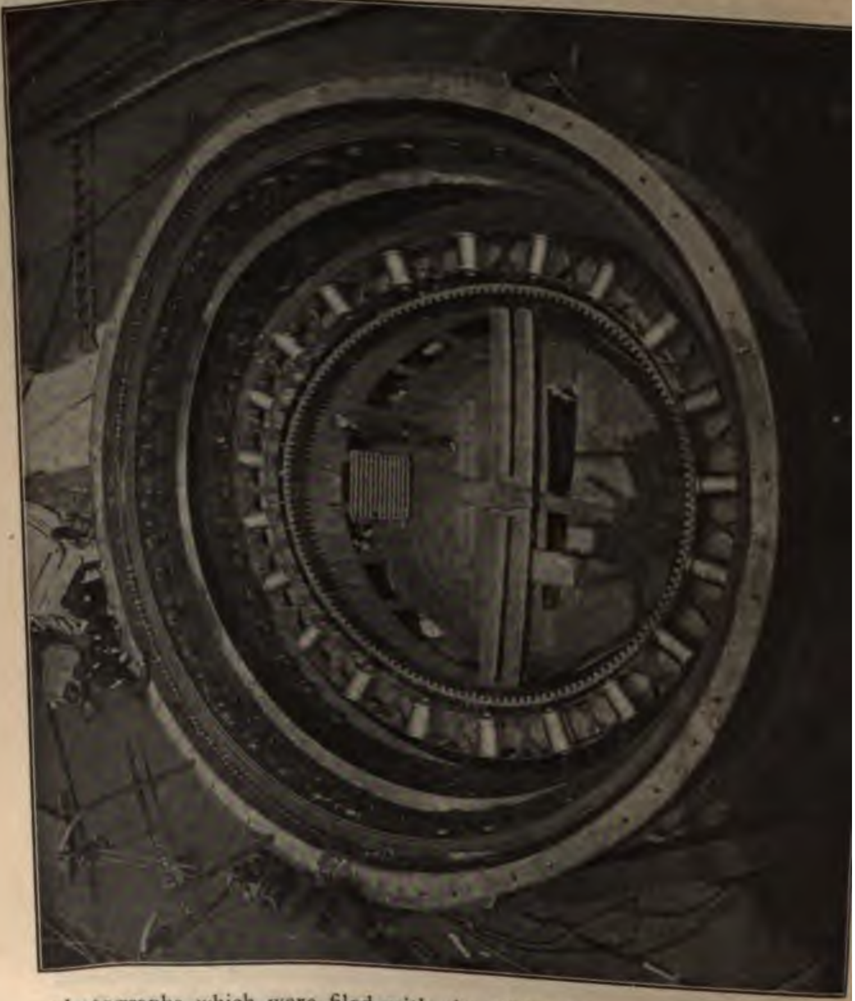
The boilers are of the Belleville type, with economizers. There ar
in all, of which 20 consist of eight elements of generating tubes
seven elements of economizer tubes; while the remaining five boilers h
seven elements of heating and six elements of economizer tubes.
total heating surface is 37,452 square feet, and the grate area 1276 squ
feet. The two funnels are 14 feet in diameter over the casings,
height from the firegrate being 91 feet. There is the usual compl
system of pumps, with blowing engines for the furnaces. The t
weight of the machinery is 1355 tons. The machinery is practically c
pleted and ready to be placed on board the ship, which is to be comple
for sea in May of next year.—*Engineering*, Nov. 16, 1900.

THE FIRST-CLASS BATTLESHIP ALABAMA.

The Alabama, whose record of 17 knots an hour on her recent official trip, places her at the front rank of our battleships for speed, will always be a vessel of particular interest, from the fact that in her we see the introduction of a new type in the United States navy. Comparing her with the Oregon, the Iowa or the Kearsarge, the most noticeable difference is the entire absence of the 8-inch gun. Hitherto our battleships have been distinguished from those of other navies largely by the fact that they carried a much heavier armament, due chiefly to the presence on board of a complete battery of guns which were intermediate in power between the main battery of 12-inch and 13-inch guns, and the secondary battery of rapid-fire guns of 5-inch and 6-inch caliber. The battleships of Great Britain, France and Germany, and with a few exceptions of Russia, have carried no guns of a caliber between the 12-inch and the 6-inch weapons, and in the Alabama we see the first disposition on the part of our naval constructors to follow the European practice. Although the absence of the 8-inch gun is very sincerely regretted by most of our officers of the line, it cannot be denied that in the Alabama the heavy secondary battery of 6-inch guns, on account of its rapidity of fire and the enormous weight of metal which can be thrown in a specified time, goes far to offset the removal of the very popular 8-inch breech-loading rifle.

The Alabama was authorized June 10, 1896; the contract for her construction by the William Cramp & Sons Ship and Engine Building Company was signed the following September; the keel was laid the December of the same year, and the vessel was launched on May 18, 1898, and has now been completed about eleven months later than the contract date, the delay being due to the failure of the builders, on account of the armor-plate controversy, to receive the necessary armor during the construction of the ship. The vessel is 360 feet long, 72 feet 2½ inches broad, and has a mean draft, when fully equipped for sea, and with 800 tons of coal on board, of 23 feet 6 inches. Her displacement on the draft given is 11,565 tons. She is driven by twin-screw, vertical, triple-expansion engines, and steam is supplied by boilers of the Scotch type. Her normal coal supply is 800 tons and her bunker capacity with nominal loose stowage is 1200 tons, while with close stowage she can hold 1440 tons in the bunkers. As compared with the Kentucky and Kearsarge, she has about 8 feet more freeboard, due to a spar deck which extends from the bow about two-thirds of the way out. Her protection consists of a belt of Harveyized armor of a maximum thickness of 16½ inches, which tapers toward the bow and stern. Above the belt, amidships, side armor of 6 inches is carried up to inclose and protect the guns of the secondary battery. The main battery of four 13-inch guns is carried in elliptical balanced turrets which have 14 inches of armor protection. The secondary battery is extremely powerful and consists of fourteen 6-inch rapid-fire guns, twelve of which are carried on the main deck and two on the boat deck amidships. She is also armored with sixteen 6-pounders, six 1-pounders, four Colts, and two 3-inch field guns. She is fitted with four tubes for the discharge of Whitehead torpedoes.

In various articles on naval matters which have appeared from time to time in the *Scientific American*, we have described and illustrated, with sectional views, the structural features of the barbette of a modern warship; but we think that the most knowing of the naval "sharps" amon our readers will be able to learn something from the accompanying illustration showing the interior of a barbette before the turret was installe The photograph from which our plate was made is one of a series



photographs which were filed with the Chief Constructor of the Navy during the construction of the Alabama. It was taken from the after end of the superstructure, the deck upon which the people around the edge of the barbette are standing being the main deck.

The barbette is a vertical, cylindrical, heavily armored redoubt, which extends from the protective deck to a height of 3 feet 8 inches above the main deck. The duty of this redoubt is to protect the unarmored base of the turret, the mechanism by which it is rotated, and the hoist by which the ammunition is brought up to the guns. Within this cylinder, which is about 12½ feet in depth, is located a circular track upon which is a circle of twenty-one conical rollers, which are held in their proper spacing and radial position by means of two concentric rings, firmly braced together, as clearly seen in the illustration. Upon these rollers is carried the whole weight of the turret, the guns and their mounts, a total of 277 tons. The lower half of the turret is in the form of a circular-inverted cone and is unarmored; the upper and armored portion of the turret is elliptical in plan, and the rear portion of it projects over the top edge of the barbette, enough space being left between the turret and barbette for easy clearance in turning.

The barbette is protected for two-thirds of its circumference with 14 inches of Harveyized armor, the remaining one-third, or the portion which is nearest to the point of view from which the photograph was taken, is protected with 10 inches of armor, less protection being needed on this portion of the barbette because it is screened by the 6-inch side armor on the hull of the vessel. The armor is bolted to a backing of teak, within which is 1 inch of steel plating attached to a heavy framing of steel beams, angles and channel beams. The internal diameter of the barbette is 27 feet.

Immediately within and below the circle of rollers is seen the massive circular rack which forms part of the turning mechanism of the turret, rotation being effected by means of two electric motors carried in the base of the turret. The shafts of these motors are connected by suitable gearing with pinions which engage the circular rack; and the training of the great weight of the turret and guns is accomplished with a speed and accuracy which are impossible when hydraulic, compressed air, or steam motors are used.

The after barbette of the Alabama contains altogether 26 tons of armor. The total weight of the installment, including turrets and guns, is 783 tons. The forward barbette and turret, however, are much heavier, the total weight in this case being 978 tons. This increase is due to the fact that the Alabama carries her forward guns above the spar deck, and, therefore, some 7½ feet to 8 feet higher above the water-line than the after pair of guns, the increase in weight being due entirely to the increased height of the barbette.—*Scientific American*, Sept. 8, 1900.

THE NEW BATTLESHIPS.

The *Scientific American* published, in its issue of June 9 last, an illustration and description of the three battleships then designated Georgia, Pennsylvania and New Jersey. Some time later, after the report of a special board, the Navy Department assigned those names to the three ships that are to carry superposed turrets, while the two vessels appropriated for by the last session of Congress, bearing the names of Virginia and Rhode Island, will be as described and pictured in our issue of last June.

Without going into the merits of the case, the majority decision of the special board in favor of arming three of the five new battleships with superposed turrets followed directly upon the final acceptance trials of the Kearsarge. The object of the board's being was the determining of

the better type of ship, all five, of course, to be alike, and the decis
or recommendation showed the board to be hesitating in judgment.
result is to miss the prime opportunity of fashioning five ships of absol
similarity, a feature of fighting efficiency in combined operations har
to be overvalued.

In general dimensions, these ships will be like those described p
viously. They will have a load-water-line length of 435 feet; an extre
beam of 76 feet 10 inches; a trial displacement of 15,000 tons; a m
draft at trial displacement of 24 feet; a greatest draught, full load, of
feet; a total coal-bunker capacity of 1900 tons; and a trial speed of
knots.

The most important difference in hull between these ships and the
of later appropriation is in the wood-sheathing and coppering wh
these ships will receive. Throughout the bottom and bilges and up t
height of three or four feet above the water-line there will be a th
covering of fine pine carefully tapped to the underlying metallic skin
rendered water-tight and non-galvanic. Over this will be laid the copp
The advantages of this system are too well known to need explanat
here; and, in consequence, the ships will prove far more economical
their consumption of coal, readier at all times for high-power service,
able to maintain their speed even after months in the fouling waters
the tropics. Such of our sheathed and coppered craft as have do
service in the Far East have proved valuable practical examples of
advantages of this system of bottom protection.

In hull form there will be a novelty, common to all five of the n
battleships, in the way the uniform freeboard of 20 feet is maintain
from bow to stern. Apart from the military advantage gained in
added height of the guns of the main battery aft, there will be a net g
in accommodations of infinite comfort and healthfulness to both offic
and crew. None of them will be shut up behind the blank walls of hea
armor, as heretofore, lighted only by artificial means, but the livi
spaces will all have air ports and direct access to sunlight. This add
freeboard aft, too, will make the ships more weatherly in a following s

The armor protection to the hull will consist primarily of an 8-f
water-line belt, 5 feet of which will be below water at load draft. T
maximum thickness of this belt is maintained amidships for a distan
of 192 feet abreast the engines and boilers. From the top downward
feet, this armor will be 11 inches through, and thence to the armor sh
will taper to 8 inches. The belt is continuous from bow to stern
varying thicknesses. For a distance of 60 feet forward and 32 feet ab
the central portion, the plates are to have a maximum thickness of
inches and a minimum of 6, the maximum 9 inches ranging downward
feet. For a distance of 16½ feet forward and aft, the next course
armor will have a greatest thickness of 6 inches and a least thickness
4½, the limits of dimensions, as in all following cases, being similar
those in the portions already described. Seventeen feet forward and
next, the armor will have a maximum thickness of 5 inches and a mi
mum of 4, while the remaining armor, running forward to the bow a
aft to the stern, will have a uniform thickness of 4 inches. This arm
will be treated by the Krupp process.

Above the main belt, for a distance of 245 feet amidships, *i. e.*, throug
out the position of the main broadside rapid-fire battery of 6-inch gu
the sides will be reinforced by armor of a uniform thickness of 6 inch

This armor will reach all the way up to the main deck, and it will be joined to the barbettes of the 12-inch turrets by athwartship armor of 6 inches in thickness aft, and by inclined armor of like thickness forward, yielding, in this latter case, the added protection of glacis against the head-on raking fire of an enemy. The after athwartship armor is vertical.

There will be a curved protective deck, reaching from bow to stern, being 1½ inches thick on the flat and 3 inches thick on the slopes. A cellulose belt 3 feet in thickness will be worked continuously from bow to stern along the sides above the protective deck. The obturating material will be the well-known cornpith cellulose.

Wood will be used very sparingly, and, where indispensable and not exposed either to the weather or under water, will be fire-proofed. Light metal bulkheads will supplant the usual wooden partitions in the living spaces, some of the furniture will be of pressed metal, the chart-house will be of bronze, and all of the decks under cover will be laid with linoleum. To guard against the overheating of the magazines, there will be a 4-inch air space around them in addition to a coating of some non-conducting material, while certain of the magazines are to be arranged so that they may be chilled by compressed air from the refrigerating plant.

Each ship will be fitted as a flagship, and accommodations will be provided for 1 flag officer, 1 commanding officer, 1 chief of staff, 20 ward-room officers, 12 junior officers, 10 warrant officers, and 658 seamen and marines; a total complement of 703 persons.

The refrigerating plant on each ship will have a cooling equivalent of two tons of ice daily; and a steam laundry, capable of handling the clothes of seventy-five persons per diem, will do most of the washing and ironing for officers and enlisted men.

The fighting powers of the vessels will be centered in the main battery of four 12-inch and eight 8-inch breech-loading rifles, the main rapid-fire battery of twelve 6-inch breech-loading rifles, the secondary rapid-fire battery of twelve 14-pounders and a dozen 3-pounders, and the auxiliary battery of eight 1-pounders, two field pieces, two machine guns, and a half-dozen 0.3 automatic guns.

The four 12-inch rifles will be mounted in two elliptical, balanced turrets 10 inches thick except for the slanting port plates an inch heavier. These guns will fire through arcs of 270 degrees. Four of the 8-inch guns will be superposed upon these turrets, fixed to move in unison, and they will be sheltered by walls of 6-inch armor increased half an inch on the slanting face plates. The four remaining 8-inch guns will be mounted amidships, two on each side, on the main deck, and will be housed in independent turrets similar to those placed above the 12-inch guns. These 8-inch rifles will have arcs of fire of 180 degrees, ranging from dead ahead to dead astern. This arrangement of the 12- and 8-inch guns gives a bow and a stern fire of six 8's and two 12's, and a broadside of six 8's and four 12's.

The 6-inch guns are arranged in broadside similarly to the ships previously shown last June. Each 6-inch gun, of which there are six on each broadside, has an arc of fire of 110 degrees, and the ports are so arranged that the guns can be turned inboard within the side line, the guns swinging toward one another in pairs; beginning forward, the first gun turns aft while the next one swings its muzzle forward, etc., to the after pair. This arrangement does away with the inconvenience of dismounting the guns to avoid obstructions or to guard them against the stress of h weather. Each of these guns is sheltered behind a heavy port sl and there is a splinter bulkhead of 2½-inch nickel steel between each and its neighbor on either side. The 14-pounders, sheltered by armor of 2-inch steel and shields, are to be mounted on the gun well forward and aft, and up in the superstructure on the main forward and aft of the amidship 8-inch turrets. The twelve 3-pour are to be mounted on the bridges and on the superstructure deck, the 1-pounders, automatic and otherwise, and the Gatlings, are t placed in the tops and in the boats.

The submerged torpedo-tubes, of which there are two, are t placed, one on each side, well forward, and the operator is to contro tube from an armored station on the deck above, sufficiently shelt to be proof against 6-pounder fire.

The rates of fire given previously for the two other battleships app the case of these vessels and will be as follows: With ammunition plied as fast as the electrical hoists can bring it to the guns, the 12- guns will fire once in every 1½ minutes; the 8-inch guns once in e 50 seconds; and the 6-inch guns three times a minute.

The motive engines will be of the four-cylinder triple-expansion t actuating twin screws, and capable of developing 19,000 indicated ho power. The steam pressure will be 250 pounds, the stroke four feet, the cylinders will be, H. P. 35 inches, I. P. 57 inches, and two L. P. of 66 inches. Number of revolutions a minute, 120.

There will be twenty-four boilers of the straight water-tube t placed in six water-tight compartments. They will have quite 1280 sq feet of grate and 55,000 square feet of heating surface. The air pres in the ash-pits will not exceed one inch of water. On trial, the ships carry only 900 tons of coal, and a reserve of 66 tons of fresh water be carried either in tanks or in the double bottom during that time. originally contemplated, one 50-foot steam-cutter or picket-boat wa have been carried by each ship, but since the report of captains of attacking fleet during the recent maneuvers at Newport, it is hi probable that each ship will be given two for vidette service aga torpedo-boats or submarine craft.

Each ship will carry quite 570 tons of offensive ammunition, not co ing torpedo outfit.

Thirty-six months is the maximum time allowed for the buildin each ship, and the limit of cost is $3,600,000, exclusive of armor armament.

These ships were authorized by the act of Congress approved Marc 1899.—*Scientific American*, Nov. 17, 1900.

THE NEW ARMORED CRUISERS OF THE CALI- FORNIA AND MARYLAND TYPES.

No feature of our latest naval programme shows more forcibly impress of the lessons learned by our late war with Spain than the armored cruisers now nearly ready for the bidding contractors. new battleships are typically fine craft and thoroughly up to date; it is the armored cruiser that marks most sharply the pace we have out for ourselves. The armored cruiser, besides being the eyes and of the fleet, will take its place if need be in the line of battle. The New York was an advance upon her British prototype; the Brooklyn was an improvement; but the California and her class are really second-class battleships with armored-cruiser speed, any one of which against the combined batteries now on the New York and Brooklyn could hold its own with a very fair prospect of giving the two other ships a pretty bad drubbing. Such is the rapid rate of naval development to-day. The six ships in question were provided for by the acts of Congress of March 3, 1899, and June 7, 1900, respectively, three ships being appropriated for at each time; and those of the earlier act are required to be sheathed and coppered, while the last three allowed for were not so specified. Should authority be given to sheathe and copper the latter vessels, the contractors must stand ready to do so.

The general dimensions of the sheathed and coppered ships are as follows:

Length on load water-line	502 feet.
Beam, extreme, at load water-line	70 "
Trial displacement, about	13,800 tons.
Mean draft at at trial displacement, about	24 feet 6 inches.
Greatest draft, full load	26 " 6 "
Coal carried on trial	900 tons.
Total coal bunker capacity	2,000 "
Feed water carried on trial	75 "
Speed not less than	22 knots.
Maximum indicated horse-power	23,000

The only dimensional particulars in which the unsheathed ships will differ from the others are a maximum beam six inches less and a lighter trial displacement by 400 tons; in other respects they are alike.

The ships will have the usual extensive bulkhead system and close water-tight subdivisioning common to all modern fighting ships, and the double bottom will be so arranged that a reserve supply of fresh water may be carried there. The ships will have both docking and bilge keels. The main deck will be the only wooden deck, the others being laid with linoleum; and the use of wood will be restricted to the last degree, all of that within the vessels being fire-proofed.

The fighting positions and the "vitals" will all of them be sheltered behind walls of Kruppized steel, and the arrangement of armor protection will be as follows: First, a water-line belt 7 feet 6 inches wide extending from bow to stern. The belt carries its maximum thickness 4½ feet from the top down, whence it tapers to the armor ledge. For a distance of 244 feet amidships, the armor will have a maximum thickness of 6 inches and a minimum of 5; thence to the bow and to the stern the belt will have a uniform thickness, top and bottom, of 3½ inches. For a distance of 232 feet amidships, above the water-line belt and up to the main deck, the sides will be reinforced by 5-inch armor; transverse bulkheads, turning inboard at the ends of this side armor, will complete the central casemate housing the ten 6-inch guns. These transverse bulkheads will be 4 inches thick. The protective deck will be continuous from bow to stern; on the flat it will be 1½ inch thick and on the slopes 4 inches thick. Above this protective deck a cellulose belt 3 feet thick will be worked along the sides from one end of the ship to the other. It is required that the water-line armor belt be so placed that at least a foot of it will be out of water at deepest draft.

The armament will consist of: A main battery of four 45-caliber, 8-i
breech-loading rifles and fourteen 50-caliber, 6-inch breech-loading rif
and a secondary battery of eighteen 14-pounders, twelve 3-pounders, f
1-pounder automatic guns, four 1-pounder single-shot guns, two 3-i
field guns, two machine guns, and a half a dozen small caliber pieces
boat service. There will be two submerged torpedo-tubes, to be pla
on the broadsides pretty well forward. The 8-inch guns are to
mounted in two balanced elliptical turrets on the main deck forward
aft of the superstructure. These turrets will be generally 6 inches th
with slanting faces ½ inch thicker. The turrets are to be control
electrically, and are to fire through arcs of 270 degrees. The rate
ammunition supply is one complete round of powder and projectile
each electric hoist every fifty seconds.

The four 6-inch guns mounted on the main deck are to be placed
sponsons at the four main corners of the superstructure, and are to f
through arcs of 145 degrees—the forward ones from dead ahead aft, a
the after ones from dead astern forward. These guns are protected
5-inch armor. The ten other 6-inch guns, five on each broadside, are
be placed amidships on the gun deck—the forward ones firing de
ahead, while all the other guns on each side will have arcs of fire of 1
degrees, and will be arranged to house within the side line. These gu
will be separated by 2¼-inch splinter bulkheads. The ammunition hois
will be run by electricity, and are to supply each 6-inch gun with thr
complete rounds every minute. The 14-pounders will be mounted c
the gun deck and up in the superstructure, two forward and three a
of the 6-inch battery on each side, and four on each broadside betwee
the 6-inch guns up in the superstructure. The 3-pounders are to b
mounted on the superstructure deck and on the bridges, while most of th
1-pounders are to fill the military tops. Each 14-pounder is to be sup
plied six rounds a minute, while the 3-pounders are to have ten.

The firing stations for the torpedoes will be sheltered from the reac
of 6-pounders and lighter pieces, and are to be located above the torpedo
tubes. The conning-tower, located at the fore end of the superstructure
will be of steel 9 inches thick, and the signal tower, located at the afte
end of the superstructure, will be of steel five inches thick. The pilot
house will be of bronze. All magazines are to be carefully insulated
and certain of them are to be chilled by the refrigerating plant. All are
also to be easily susceptible of instant flooding.

Because of the extensive application of electricity, the ships will carry
pretty large generating plants, having a total output from the seven
units of 6250 amperes at 80 volts—power enough to run all the ammunition hoists, work the turrets, drive some of the ventilating fans, run the
machine shop, and furnish power for the steam laundry which is to do the
major share of the officers' and crew's washing. Owing to the high freeboard of the ships and to the fact that it is carried uniformly from bow
to stern, very excellent accommodations will be provided for the officers
and enlisted men, of which the complement will consist of: 1 flag officer,
1 commanding officer, 1 chief of staff, 20 ward-room officers, 12 junior
officers, 10 warrant officers, and 777 enlisted men, a total of 822 persons.

The ships will have twin screws, driven each by its own triple-expansion engine of the four-cylinder type. The high-pressure cylinders will
be 36 inches in diameter, the intermediate-pressure cylinders will be 59½
inches in diameter, and the two low-pressure cylinders of each engine

will be 69 inches in diameter. They will have a common stroke of 45 inches, and the engines will make about 133 revolutions when developing the maximum indicated horse-power of 23,000. Steam will be supplied by 30 boilers of the straight-tube water-tube type placed in 8 water-tight compartments. They will have a combined grate surface of at least 1590 square feet and a total heating surface of quite 68,000 square feet. The four funnels will rise 100 feet above the grate bars. The normal reserve of fresh water will be 150 tons—just half of that carried on trial, and, excepting coal, the trial displacement will call for two-thirds of all other stores.

The ships will carry ammunition enough to put up a good long fight; 500 rounds being allowed the 8-inch guns, 2800 rounds for the 6-inch guns, 4500 rounds for the 14-pounders, 6000 rounds for the 3-pounders, and a pretty liberal supply for the rest. Provision is to be made for closing many of the water-tight doors automatically, *i. e.*, from a single controlling station, and every care has been taken to minimize the consequences of accident or injury. Three years is the maximum time limit for the construction, and the maximum limit of cost is $4,000,000 in the case of the ships of 1899 and $4,250,000 in the case of the ships provided for during the present year.

We have ample reason to be proud of these latest products of our naval designers; and in either peace or war they are bound to command a wholesome respect.—*Scientific American*, Dec. 1, 1900.

LAUNCH OF THE MONITOR WYOMING.

The Wyoming was launched at the Union Iron Works, San Francisco, on September 8, in the presence of His Excellency the Governor of Wyoming and an enormous crowd of spectators. While a powerful vessel, the Wyoming is considerably less in dimensions compared with the Monterey, though both are practically of the same type. The Monterey is 255 feet in length, and is 59 feet beam, with a depth of 14 feet 10 inches. The Wyoming's dimensions are: Length, 252 feet; beam, 50 feet; and mean draught, 12 feet 6 inches. The side armor of the former vessel is 13 inches in greatest thickness, tapering to 8 inches at the ends; of the latter, 11 inches, tapering to 3 and 5 inches. Displacement: Monterey, 4084; Wyoming, 3235; horse-power engines, 5244 and 2400 respectively; speed, 13.6 and 12.

The armament of the Monterey consists of two 12-inch and two 10-inch main battery, six 6-pounders, four 1-pounders, two Gatlings. Of the Wyoming, two 12-inch, four 4-inch rapid-fire, two 6-pound semi-automatic, four 1-pound automatic, and additional four automatic 1-pounders have been authorized.

Although the Wyoming will carry only two heavy guns, as compared with four carried by the Monterey, the increased power of her two 12-inch rifles, due to greater length and smokeless powder, is such that one round from them will have 12,800 foot-tons more energy than one round from the four guns of the larger vessel.

The keel of the new monitor was laid in October, 1899, and her completion is promised in six months.—*Scientific American*, Oct. 13, 1900.

THE PROTECTED CRUISERS OF THE ST. LC CLASS.

A point has been reached in the development of the new Unite
navy in which we not only have ceased to follow the lead of othe
but are producing original designs of ships and novel details w
being followed by foreign constructors. It is true that in size the
States navy stands fourth among those of the world, but in
material, equipment and efficiency it is the equal, if not the sup
any other navy. This result is due largely to the ability and er
the Bureau of Construction and Repair, which, under the Chi
structor, Rear-Admiral Philip Hichborn, has been responsible
design, construction and maintenance in a state of efficiency of c
navy. The latest products of this Bureau are fourteen vessels,
construction has recently been authorized, namely, five battlesl
about 15,000 tons displacement, six armored cruisers of about 14,c
displacement, and the three protected cruisers which form the su
the present article, of a little under 10,000 tons displacement.

The protected cruisers, to be named the St. Louis, Milwauk
Charleston (the latter to continue the name of the 3700-ton vessel w
November 2, 1899, off Kamiguin Island in the Philippine group
pare favorably with their class in other navies. In fact, so clo
they approach the type of second-class armored cruisers that they
easily be mistaken for such. In an engagement they would prove
selves a match for some of the armored cruisers of other nav
comparison of their principal data with that of the British Mor
class will demonstrate their value.

	UNITED STATES.	GREAT BR
	St. Louis, Milwaukee, Charleston.	Monmouth, Kent, Bed
Length on load water-line	424 feet.	440 feet.
Breadth, extreme	66 feet.	66 feet.
Trial displacement	9,700 tons.	9,800 tons.
Mean draft at normal displacement	23 feet 6 inches.	24 feet 6
Engines, twin-screw, I. H. P.	21,000	22,000
Speed	22 knots.	23 knots.
Normal coal supply	650 tons.	800 tons.
Coal bunker capacity	1,500 tons.	1,600 tons.

ARMAMENT.

Fourteen 6-inch R. F. guns.	Four 6-inch R. F. gun, in turrets
Eighteen 14-pdr. R. F. guns.	Ten 6-inch R. F. guns in casemat
Twelve 3-pdr. R. F. guns.	Ten 12-pdr. R. F. guns.
Four 1-pdr. automatic.	Three 3-pdr. R. F. guns.
Eight 1-pdr. R. F. guns.	Eight machine guns.
Two 3-inch R. F. field guns.	
Two machine guns, 0.30 caliber.	
Eight automatic guns, 0.30 caliber.	

PROTECTION.

Main side armor	4	inches.	4 inches, tapering to 2 inches a
Lower casemate armor	4	"	
Upper " "	4	"	
6-inch gun protection	4	"	4 inches.
Conning tower and shield	5	"	
Signal tower	4	"	
Splinter bulkheads	2	"	
Protective deck	2½	"	Two decks, 1½ inches and ¾ inc

The act authorizing the St. Louis class states that these vessels shall carry "the most powerful ordnance for vessels of their class, and have the highest speed compatible with good cruising qualities and great radius of action"; all these qualifications have been embodied in the design for these vessels.

The main deck of these cruisers is supplemented amidships with a covered superstructure, within which are located four 6-inch rapid-fire guns and six 14-pounder rapid-fire guns; outside the superstructure are two more 6-inch rapid-fire guns, located on the center line, one forward and the other aft. Located on the gun deck is the greater portion of the battery, consisting of eight 6-inch rapid-fire guns, twelve 14-pounder rapid-fire guns, and four 1-pounder rapid-fire guns. Sixteen rapid-fire guns are stationed on the superstructure deck and bridges, and the remainder of the battery is located in the fighting tops of the two military masts. Additional platforms are built upon the masts to accommodate the two searchlights. Electric ammunition hoists are designed to supply the guns with the greatest rapidity, making it possible to hurl against an enemy a broadside of about twelve tons of metal per minute.

The four lofty smokestacks, extending to a height of 76 feet 6 inches above the normal load water-line, provide draft for sixteen straight water tubular boilers located in four water-tight compartments, which, together with the engines, are protected by the side armor, sloping deck armor, and a 12-foot coal-bunker.

The inner bottom of these vessels extends to the under side of the protective deck; above the protective deck a cellulose cofferdam, 30 inches wide and 41 inches above the normal load water-line, extends throughout the length of the vessel.

In the construction and equipment of the St. Louis class, as small a quantity as possible of wood is to be used, and wherever it is used it will be electric fire-proofed. Each vessel of this class is fitted to accommodate a flag officer and staff in conjunction with the regular complement. In commission the number of officers will be 39 and the crew will number 525 men, for which are provided 16 boats, ranging from a 36-foot steam cutter to a 16-foot dinghy, and in addition to these two 12-foot punts and two life-rafts will be carried. These boats are stowed in chocks on the superstructure deck and swung out by four cranes.

All the latest and best improvements in construction and equipment are to be provided for the accommodation and comfort of the officers and crew.

The water-line belt, 4 inches in thickness, extends in the wake of the engines and boilers and magazines for over one-third of the vessel's length, and reaches from several feet below to about 3 feet above the normal water-line. Side armor of the same thickness is carried up amidships to the main deck, and extends between and includes the forward and after 6-inch guns on the gun deck. The 6-inch guns at the four corners of the superstructure are also protected by 4-inch armor.

While we greatly admire these vessels, we must express a regret that the water-line armor was not carried up to the bow, even if some compromise had been necessary in the matter of coal or armament. This is an age of armored cruisers (*i. e.*, ships with a complete water-line belt), and it is regrettable that these vessels should fall short of the requirements for want of the 120 feet of 2- to 3-inch armor necessary to complete the belt to the stem.

The corn-pith cellulose cofferdam at the water-line, with its wate excluding properties, will safeguard the trim and stability of the S Louis against all but the smaller 6- and 14-pounder shells about effectively as if the 2-inch belt were extended to the stem; but it wi be just these very small caliber guns that will be used to search out an cut to pieces the unprotected ends of an enemy's water-line.

It must be admitted that the new ships, although they are not quite i the class of the armored cruisers, are nevertheless more than a matc for any protected cruiser afloat.—*Scientific American*, Dec. 22, 1900.

THE FIRST-CLASS BATTLESHIP WISCONSIN.

The first-class battleship Wisconsin, recently completed by the Unio Iron Works, possesses interest for our readers from the fact that she wa built in the yard which turned out the famous battleship Oregon. Th latter vessel, like the Wisconsin, is one of a class of three ships, and lik her she is the fastest in her class. The Alabama, the Illinois and Wisconsin were authorized on June 10, 1896. The first-named vessels wa allotted to the Cramps, of Philadelphia, and has already undergone he trials with great success, achieving a speed of 17.01 knots an hour. Th Illinois is approaching completion at the yard of the Newport New Shipbuilding Company, and the Wisconsin has recently completed he official trials, on which she made an average speed of 17.17 knots pe hour. The principal dimensions of the vessel are as follows: Length 368 feet; beam, 72 feet 2½ inches; mean draft, when the ship is full equipped ready for sea, with all stores on board and a normal coal suppl of 800 tons, 23.6 feet. The displacement of the vessel with two-thirds o ammunition and two-thirds of stores on board is 11,565 tons. He bunkers have a maximum coal capacity of 1440 tons. She is propelle by twin engines. They are of 10,000 estimated indicated horse-power although this was considerably exceeded on the trial trip, when the maximum indication reached 12,322. They are of the inverted three-crank triple-expansion type, and while they conform broadly to the specifications drawn up by the Naval Bureau of Engineering, the builders hav introduced specialties of design, which they have already used wit marked success in other naval vessels built for the government. Th most noticeable of these is the framing of the engines, which is forme of forged built-up columns at the back, and turned columns for the fron side of the engine. The forged column is of a type which was first use by these builders in the engines of the Olympia, and later in those o the battleship Oregon. It is built up of forged plate sides, on which ar flanges for securing the column to the bedplate and to the cylinder bottoms. Between the sides is bolted in the casting which forms the mai guides, and below the guides the sides are spread, and a webplate i worked in, the lower half of the frame being thus in the form of a inverted Y. It is claimed by the builders that this type of frame provides unusual rigidity, and the forged iron is more reliable than th material of the usual cast steel frames. The high-pressure cylinder i 33½ inches in diameter, the intermediate 51 inches, and the low-pressur cylinder 78 inches in diameter, the common stroke being 4 feet. Th crank shaft is made of three interchangeable and reversible sections; th crank pins are 14¾ inches in diameter by 17 inches long; and there is

7½-inch hole axially through the shaft and crank pins. The thrust shafts are 14 inches in diameter, and the propeller shafts 14¾ inches in diameter, with a 9¾-inch axial hole throughout their entire length, except in the after section, where they pass through the hub of the propeller, in which portion the hole is tapered.

The engines are fitted with straight-push, reversing gear, and the air pumps are independent of the main engine. The main circulating pumps, which supply the condensers, may be used to empty the bilge of the ship, for which purpose they have a capacity of 12,000 gallons per minute. The screw propellers are three-bladed and are made of manganese bronze. They are 15½ feet in diameter and the pitch is 17 feet 6 inches. Steam is supplied by eight single-ended steel boilers in four compartments; the boilers are 15 feet 6½ inches in diameter and 10 feet in length.

The Wisconsin is a fine, seaworthy vessel with a good freeboard of about 20 feet forward and 13 feet aft. Her main battery of four 13-inch breech-loading rifles is carried in two barbette turrets; the barbettes are plated with 15 inches of Harveyized steel, and the turrets with 14 inches. She has a water-line belt from 7 to 8 feet in depth, which varies in thickness from 16½ to 9½ inches at top and bottom respectively amidships to 4 inches at the stem. This belt extends as far aft as the after barbette. With this armor is associated a steel deck 2¾ inches in thickness on the flat, 3 inches in thickness forward, and 4 inches from the after end of the armor belt to the stern. The main rapid-fire battery consists of fourteen 6-inch rapid-fire guns, ten of which are carried on the main deck and four on the spar deck. Of these on the main deck, eight are carried within a central citadel, which is protected with 6 inches of Harveyized armor, the armor extending in the wake of the guns and running across at the ends of the battery diagonally to a junction with the 12-inch armor of the barbettes. The two other guns on the main deck are carried well forward in sponsons armed with 6 inches of Harveyized steel. The four guns on the spar deck are carried immediately above the central rapid-fire battery and are likewise protected with 6 inches of armor. The secondary battery is made up of sixteen 6-pounders, six 1-pounders, four Colts and two 3-inch field guns. There are also four Whitehead torpedo dischargers. The total complement of officers and men will be 493. Considering that the keel of the vessel was not laid until February, 1897, it is evident that improved facilities are enabling our shipbuilders to turn out these big vessels more rapidly than they could when earlier vessels of the Oregon type were built.—*Scientific American*, Dec. 8, 1900.

U. S. TORPEDO-BOAT DESTROYER DALE.

In *Marine Engineering* for August brief mention was made of the launch of the torpedo-boat destroyer Dale on July 24 at the yards of the Wm. R. Trigg Co., Richmond, Va. The following particulars will be of further interest.

The Dale is the first of the sixteen destroyers now building for the Government to be launched. As it was a side launch, unusual interest was created and upwards of 5000 people witnessed the scene.

Miss Mary H. Wilson, of Philadelphia, a descendant of Commodore Dale, after whom the boat is named, acted as sponsor and succeeded very well in breaking the bottle of "yellow label" over the bow of the

destroyer as it took its initial plunge. The boat glided smoot
ways without a hitch of any kind and came to a standstill af
gone not more than 30 feet, resting gracefully on the water,
line showing the fineness that will permit the high speed it i
to make. The dimensions and particulars of the launching wa
follows:

Groundways, 12 inches by 12 inches, yellow pine.
Groundway shoes, 12 inches by 1½ inches, oak.
Slidingways, 5½ inches by 12 inches.
Length of slidingways, 23 feet.
Inclination of ways, 2 inches to 7 feet.
Number of ways, 10.
Bearing surface, 230 square feet.
Number of triggers, 5.
Launching weights, 193 tons.
Pressure per square foot, .839 ton.

A preparation of No. 1 Albany grease and beef tallow was app
one-half inch thick on the ways and then covered with soft soa
to the heat, considerable more tallow was used than is usually

The dimensions of the Dale are as follows:

Length over all	245 ft.
Beam	23 ft.
Depth	14 ft. 3 in.
Draft	6 ft. 6 in.
Normal displacement	420 tons.
I. H. P.	8,000
Speed	28 knots.
Thornycroft boilers, Daring type	4
Total grate surface	315 sq. ft.
Total heating surface	17,768 sq. ft.
Steam pressure, boiler	300 lbs. per

Two four-cylinder triple-expansion engines. Diam. of cylinder
32 in., and two 38 in., each with a common stroke of 22 in.

TORPEDO-BOAT BARNEY.

At the yard of the Bath Iron Works, Bath, Me., on Jul
launched the U. S. torpedo-boat Barney. This boat is one of t
authorized by Congress in 1898. Her dimensions and chief
are as follows: Length, 157 feet; beam, 17 feet; depth amidshi
9 inches; mean draft, 4 feet 8 inches; displacement, 160 tons;
knots; cost $170,000. The armament will consist of three pair
guns and three tubes for short 18-inch Whitehead torpedoes
Engineering, Sept., 1900.

BOOK REVIEW.

THE FRIGATE CONSTITUTION.

In giving to the public this interesting, well-written and reliable history of the most famous ship of our navy, Prof. Hollis has done a good work, and is to be congratulated. Though the book is not a naval history, the reader will get a very good idea of the events connected with the establishment of the navy and its administration during the first half of the 19th century.

The numerous illustrations add much to the value of the book.

Navy officers will be glad to find that, even in a book intended for popular reading, the author has seen fit to use technical and nautical terms in describing sea-fights, rather than the mongrel vocabulary that mars some of the so-called popular histories of the navy. J. P. P.

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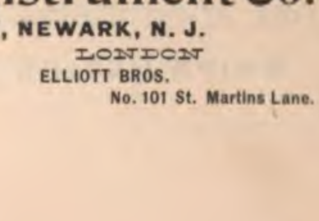

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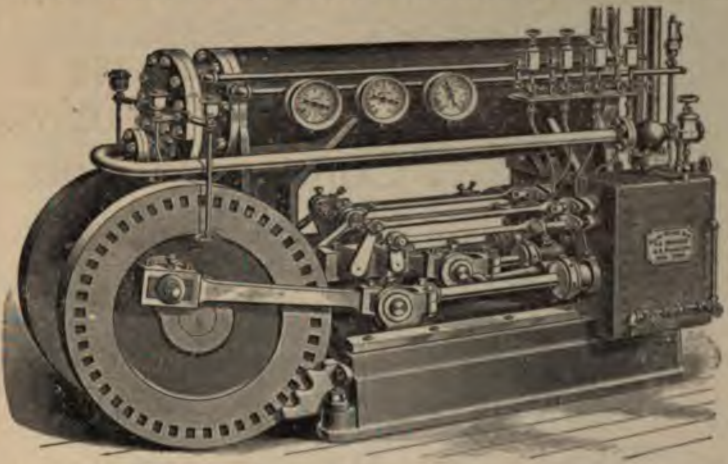

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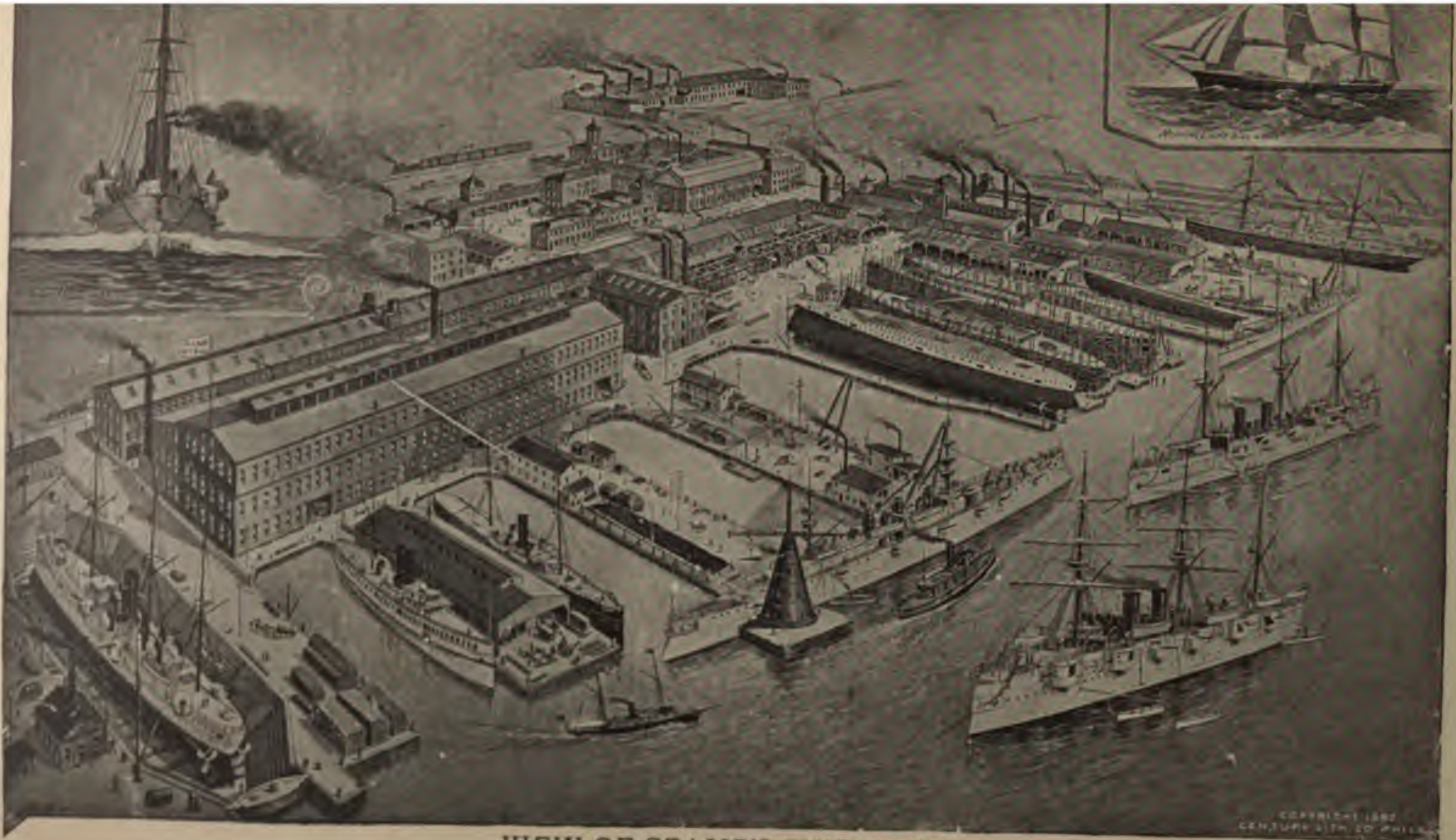

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The writers only are responsible for the contents of their respective articles.

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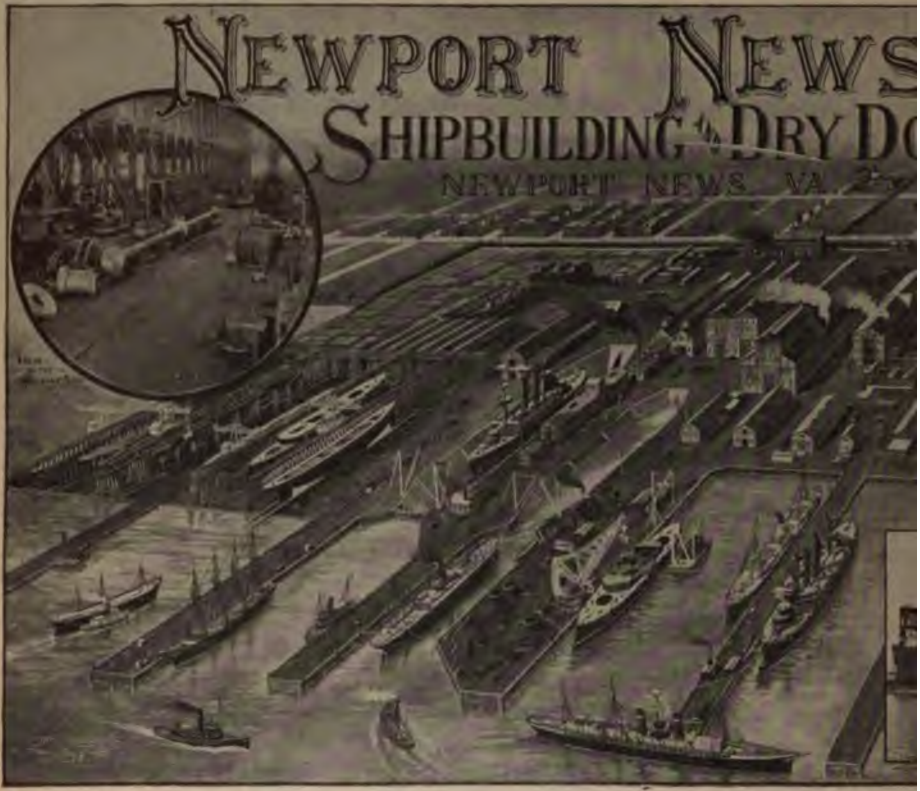

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